



***RECORD OF DECISION
Manchester Annex
Superfund Site
Manchester, Washington***

***Prepared for
U.S. Army Corps of Engineers
Seattle District***

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ATTACHMENT A RESPONSIVENESS SUMMARY

ACRONYMS AND ABBREVIATIONS

AET	apparent effects threshold
ARAR	applicable or relevant and appropriate requirements
BMP	best management practice
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPC	Chemical of Potential Concern
Corps	U.S. Army Corps of Engineers
CPF	Cancer Potency Factor
DoD	Department of Defense
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
FUDS	Formerly Used Defense Site
GSA	General Services Administration
IAG	Interagency Agreement
IRIS	Integrated Risk Information System
MFS	minimum functional standards
MTCA	Model Toxics Control Act
NCP	National Contingency Plan
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
O&M	Operations and Maintenance
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PSDDA	Puget Sound Dredge Disposal Analysis
PSNS	Puget Sound Naval Shipyard
QA/QC	quality assurance/quality control
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RfD	Reference Dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SMS	Sediment Management Standards
SPLP	Synthetic Precipitation Leaching Procedure
SQS	Sediment Quality Standards

SWQS	State Water Quality Standards
TBC	to-be-considered
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbon
UCL	Upper Confidence Limit
USFWS	U.S. Fish and Wildlife Service
USGS	United State Geological Survey
UST	Underground Storage Tank
WAC	Washington Administrative Code
WDFW	Washington State Department of Fish and Wildlife

µg/kg	micrograms per kilogram equivalent to parts per billion (ppb)
mg/kg	milligrams per kilogram equivalent to parts per million (ppm)
µg/L	micrograms per liter equivalent to parts per billion (ppb)
mg/L	milligrams per liter equivalent to parts per million (ppm)

**RECORD OF DECISION
MANCHESTER ANNEX SUPERFUND SITE
MANCHESTER, WASHINGTON**

DECLARATION

Site Name and Location

Manchester Annex Superfund Site
Manchester, Washington

Statement of Basis and Purpose

This decision document presents the selected remedial action for the Old Navy Dump/Manchester Annex Superfund Site (Site) in Manchester, Washington. This remedial action was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Control Contingency Plan (NCP). This decision is based on the Administrative Record for the site.

The remedy was selected by the U.S. Army Corps of Engineers (Corps) and the U.S. Environmental Protection Agency (EPA). The Washington State Department of Ecology (Ecology) concurs with the selected remedy.

Assessment of the Site

Actual or threatened releases of hazardous substances from the Site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

Description of the Selected Remedy

The selected remedy is the only response action planned for the Site. This action addresses all contaminated media at the Site, and consists of the following actions:

- ▶ Landfill debris located in the intertidal zone of Clam Bay will be excavated to the extent necessary to establish a stable shoreline protection system, with a goal of no net loss of aquatic habitat. Excavated material will be placed, to

the extent possible, on the upland landfill area prior to capping. Debris that is unsuitable for placement on the landfill will be tested for waste designation purposes and disposed of in an appropriate off-site landfill.

- ▶ The shoreline excavation backfill will be designed to achieve seep cleanup levels, provide the best possible habitat for marine organisms, and maximize long-term beach stability. Seeps associated with discharge from the landfill after implementation of the remedial action, if observed, will be monitored for compliance with seep discharge cleanup levels. Additional remedial measures will be implemented, as necessary, if seep discharge cleanup levels are not achieved.
- ▶ A thin cap of clean sediment will be established over intertidal Clam Bay sediment areas which exceed cleanup levels (roughly 5 acres). The overall goal is to reduce contaminant concentrations in surficial sediments sufficiently to assure that sediment dwelling organisms are adequately protected to support unrestricted use of the cap area within several years of completion of the remedial action. Clam Bay sediment and shellfish tissue will be monitored in intertidal areas currently exceeding the PCB cleanup goal for sediments (40 ug/kg [dry]) until compliance with cleanup goals is established, or until the Washington State Department of Health and the Suquamish Tribe determine that the shellfish are safe for subsistence-level harvesting, whichever comes first.
- ▶ The upland portion of the landfill will be capped in accordance with the State of Washington's Minimum Functional Standards (MFS) for solid waste landfill closures. A hydraulic cutoff system will be installed upgradient of the landfill area. After completion of upland construction, the area will be revegetated, consistent with long-term O&M requirements and site development plans. A post-closure plan for the landfill cap, hydraulic cutoff system, and shoreline protection system will be developed during remedial construction and implemented following construction.
- ▶ Dioxin-contaminated debris will be removed from the main simulator complex in the Fire Training Area and disposed of in a RCRA hazardous waste landfill. If routes of potential leakage are found in the simulator floors, soils beneath the simulators will be sampled and analyzed for dioxins. If dioxin concentrations above cleanup levels are detected, the simulator(s) will be demolished, and the underlying contaminated soils excavated.
- ▶ Near-surface soils adjacent to the main simulator complex and the soil/debris pile north of the main complex will be sampled and analyzed for dioxins. Soil and debris with concentrations above cleanup levels will be excavated, tested for waste designation purposes, and disposed of in appropriate off-site landfills.

- ▶ Concrete USTs remaining in the Fire Training Area will be closed in-place following state UST closure requirements. UST piping systems, and TPH-impacted soil excavated incidentally along with the piping, will be disposed of in an appropriate off-site landfill.
- ▶ The following institutional controls will be implemented:
 - Deed covenants to provide for the long-term protection and maintenance of the selected remedy;
 - A restriction on subsistence-level harvesting of shellfish until the Washington State Department of Health and the Suquamish Tribe determine that the shellfish are safe for subsistence-level harvesting; and
 - An institutional control plan to address TPH-impacted soil left in-place in the Fire Training Area.

Statutory Determinations

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment or resource recovery technologies to the extent practicable. However, because treatment of the principal threat at the site was not found to be practicable, this remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. Because this remedy may result in hazardous substances remaining on site above health-based levels, reviews will be conducted at 5-year intervals, at a minimum, or as required based on the performance evaluation criteria contained herein, to ensure that the remedy continues to provide adequate protection of human health and the environment.

Signature sheet for the foregoing Manchester Annex Record of Decision between the Department of the Army and U.S. Environmental Protection Agency.



Kisuk Cheung
Acting Chief, Environmental Division
Directorate of Military Programs
United States Army Corps of Engineers

30 SEP 1997

Date

Signature sheet for the foregoing Manchester Annex Record of Decision between the Department of the Army and U.S. Environmental Protection Agency.

Randall F Smith

September 30, 1997

For

Chuck Clarke

Date

Regional Administrator, Region 10

United States Environmental Protection Agency

DECISION SUMMARY

1.0 OVERVIEW

This Decision Summary provides a description of the site-specific factors and analyses that led to selection of the remedy for the Old Navy Dump/Manchester Annex Superfund Site (Site). It includes information about the Site background, the nature and extent of contamination, the assessment of human health and environmental risks, and the identification and evaluation of remedial alternatives.

The Decision Summary also describes the involvement of the public throughout the process, along with the environmental programs and regulations that may relate to or affect the alternatives. The Decision Summary concludes with a description of the remedy selected in this Record of Decision (ROD), and a discussion of how the selected remedy meets the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA).

Documents supporting this Decision Summary are included in the Administrative Record for the Site. Key documents include the Final Remedial Investigation/Feasibility Study (RI/FS) and the Proposed Plan for Site Cleanup.

2.0 SITE LOCATION AND DESCRIPTION

The Site is located approximately 1 mile north of Manchester, Washington, in Kitsap County (Figure 1). The 40-acre site is situated on the western shore of Clam Bay, an embayment off the west side of Rich Passage in Puget Sound (Figure 2). Clam Bay is typical of shallow sand-mud marine communities in Puget Sound, and supports a variety of marine resources. Commercial and experimental salmon farms also operate in the Bay.

The Site was historically owned and operated by the U.S. Navy for submarine net maintenance, fire training, and waste disposal activities. Current Site owners include the U.S. Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA); both of which operate laboratory facilities at the Site. Approximately 100 personnel work at the two laboratory facilities. Washington State Parks operates Manchester State Park, a seasonal park facility, on the extreme western portion of the Site.

The EPA Manchester Laboratory is situated in the northern 17.5 acres of the Site. The northernmost 5 acres of the EPA property includes the EPA laboratory and associated concrete parking pad and other facilities, and is also the location of the former Navy Net Depot. The remaining 12.5 acres, located in the central portion of the Site, contains a landfill area. A small portion of the northwestern corner of the landfill area extends onto Manchester State Park property.

The southern 22.5 acres of the Site was the location of a former Navy Fire Training School and is currently occupied by the NOAA National Marine Fisheries Service (NMFS). The U.S. Naval Fuel Supply Center is located south of the Site.

The Site is relatively flat, sloping to the east at roughly a 1 percent grade. Apart from the concrete parking pad in the north and the existing EPA and NMFS buildings, most of the Site's surface is vegetated with grasses, shrubs, and bushes. A localized wetland area exists at the southern end of the landfill, and an emerging wetland area may exist on the landfill itself. Along the northwestern portions of the NOAA property, and west and north of the Site in general, the terrain becomes hilly and forested.

Listed and candidate threatened and endangered species identified at the Site include the great blue heron, bald eagle, and Steller's sea lion. No archeological or historical resources have been identified at the Site. However, according to the Cultural Resources Reconnaissance report prepared for the Site, there is a moderate probability for hunter-fisher-gatherer cultural deposits.

3.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The Site was originally established as part of a 385-acre military reservation in 1898, and subsequently transferred from the War Department to the Navy in 1919. During World War II, the Net Depot and Fire Fighting School were established at the Site. These activities, and the landfill disposal history, are summarized below.

- ▶ **Net Depot.** From approximately 1940 to the early 1950s, the Manchester Net Depot functioned to construct, repair, and store submarine nets, made of steel cable and suspended from gate vessels across strategically important waterways such as Rich Passage, which guards the Puget Sound Naval Shipyard at Bremerton. The Net Depot was comprised of a large concrete pad and various structures including storage facilities and a paint and sandblasting building. Activities performed within this area of the Site

included net and buoy maintenance, sandblasting, painting, and machining operations. The Net Depot appears to have been disestablished in the early 1950s, when the area became devoted to boat storage.

- ▶ **Fire Training Area.** Formally established in 1942, the initial purpose of the Fire Fighting School was to train World War II Navy personnel to extinguish ship fires. The school included a number of features which enabled typical ship fires to be set and extinguished, such as ship compartment simulators, "Christmas trees," and "smothering tanks." Christmas trees and smothering tanks typically consisted of small, bermed concrete pads with metal superstructures for igniting waste oil for fire-training activities. Associated equipment included underground storage tanks (USTs) for gas, diesel, and waste oil; fuel lines; water lines; and pumps. Although the Fire Fighting School was formally disestablished immediately following World War II, its use may have continued during the 1950s and possibly also during the early 1970s. Three steel USTs were removed in 1994; however, at least five concrete USTs and several concrete simulators remain in this area.
- ▶ **Landfill Area.** Between approximately 1946 and 1962, the Navy filled the tidal lagoon between the Net Depot and Fire Training Area. The majority of the landfilling appears to have occurred between 1946 and 1955. The bulk of the waste included building demolition debris and burnable garbage from the Puget Sound Naval Station, along with scrap metals, steel, old submarine nets, and other debris. The resulting landfill, which has an average thickness of 6 feet and covers about 6 acres, was subsequently covered with a 1-foot thickness of sand and gravel. The southeastern edge of the landfill (approximately 1,200 feet in length) is currently exposed along the Clam Bay shoreline, and landfill waste materials have eroded into the adjacent intertidal area.

The Navy surplused 150 acres of the Station (the former Naval Station property other than the fuel depot) to the General Services Administration (GSA) in 1960, though Navy use reportedly continued to about 1962. In 1967, GSA transferred the Net Depot and most of the Landfill Area to the Public Health Service, and the property subsequently fell under EPA control. The Fire Training Area was transferred in 1968 to the U.S. Fish and Wildlife Service (USFWS), and is now under the administration of the NOAA/NMFS. The portion of the Station located north and northwest of the EPA and NMFS properties, including a small portion of the Landfill Area, was transferred to the State of Washington in 1970, becoming Manchester State Park.

Several investigations including preliminary assessments, site investigations, and a UST removal and closure action were performed by the U.S. Army Corps of

Engineers (Corps), EPA, and NOAA during the period from 1987 to 1994. Based on the findings of these investigations, the Manchester Annex Site was listed in 1994 on the CERCLA (Superfund) National Priorities List (NPL) of Hazardous Sites. Since historical Department of Defense (DoD) operations appear to be the sole cause of the contamination present at the Site, CERCLA activities are being conducted under the Formerly Used Defense Site (FUDS) program. Cleanup costs will be paid from a special fund set aside for properties formerly used by DoD.

The RI/FS for the Manchester Annex Site, completed in December 1996, was conducted by the Corps with oversight by EPA pursuant to the Interagency Agreement (IAG).

4.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

Sections 113(k)(2)(b) and 117(a) of CERCLA set forth minimum requirements for public participation at sites listed on the NPL. The Corps and EPA have met these requirements and maintained an active community relations program at the Site.

The Community Relations Plan for the Site is presented in the RI/FS Project Management Plan, available for review in the information repositories (see below). The Corps and EPA developed this Plan from discussions with state and federal agencies, elected officials, community residents, and business and interest group representatives. These interviews helped identify community concerns and interests about the Site, and helped define the best ways to work with the community during the investigation and cleanup.

Community participation has been promoted through the following activities:

- ▶ A briefing for laboratory employees who work at the Site, prior to beginning the RI/FS;
- ▶ Creation of the Manchester Annex Work Group, an advisory group
 - consisting of representatives from the Corps, EPA, the Washington State Department of Ecology (Ecology), local, state, and federal government, tribal government, interest groups, and the general public. The Work Group met approximately quarterly during the RI/FS investigation. Issues raised at these meetings helped identify community concerns and issues throughout the investigation process;

- Issuance of project Fact Sheets and invitation to participate in the Manchester Annex Work Group meetings.

The actions taken to satisfy the requirements of the federal law have also provided a forum for citizen involvement and input to the remedial action decision.

Project documents have been available for public review at the following locations:

Manchester Public Library
8067 East Main Street
Manchester, Washington

U.S. Army Corps of Engineers
Seattle District Office
4735 East Marginal Way South
Seattle, Washington

The Administrative Record is on file at the following locations:

EPA Lab
7411 Beach Drive East
Port Orchard, Washington

U.S. Army Corps of Engineers
Seattle District Office
4735 East Marginal Way South
Seattle, Washington

The decision is based on the Administrative Record for this Site.

Notice of the availability of the Proposed Plan, plus notice of a public meeting and public comment period on the Proposed Plan, was published in local newspapers. The Proposed Plan was mailed to interested parties on April 1, 1997. The public comment period lasted from April 2 to May 2, 1997. An employee briefing of EPA, Ecology, and NMFS laboratory staff on the preferred remedy was held at the Site on March 31, 1997, and a public meeting held on April 16, 1997, to answer questions and receive public comment.

In total, 54 comments were received by the Corps concerning the Proposed Plan. The comments are summarized and responses presented in the Responsiveness Summary (Attachment A) of this document.

5.0 SCOPE AND ROLE OF RESPONSE ACTION

The selected Remedial Action described in Section 11 of this ROD is intended to address potential current and future impacts to human health and the environment resulting from chemical contamination at the Site. The greatest Site risks are associated with potential skin contact and incidental ingestion of waste materials containing elevated metals and dioxin/furan concentrations. High concentrations of these compounds are found in the former landfill waste materials, simulator debris, and associated soils. There is also a threat of contaminants, primarily metals and PCBs, migrating from the landfill area into Clam Bay, where sediments and marine organisms may accumulate contaminants. The purpose of this response action is to minimize future exposure to contaminated materials, and to reduce contaminant migration into Clam Bay.

Environmental response actions, completed prior to this remedy selection process, have occurred in the Landfill and Fire Training Areas of the Site. The Navy placed a 1-foot-thick soil cap over the landfill in the late 1950s/early 1960s, to minimize direct contact with landfill wastes. Several steel USTs were removed from the Fire Training Area in 1993 under the direction of the Corps, along with limited excavation of petroleum-impacted soil.

The remedy described herein is the final response action planned for this Site.

6.0 SUMMARY OF SITE CHARACTERISTICS

This section summarizes information obtained during the RI/FS and previous site investigations, including sources of contaminants, contaminants of concern, impacted media, and potential routes of human and environmental exposure.

The validated data from the RI, along with data collected and validated from prior investigations, were screened relative to area background or local reference conditions and conservative risk-based screening criteria to identify chemicals of potential concern (COPCs) at the Site. Risk-based criteria used to screen the sampling data included:

- ▶ Model Toxics Control Act (MTCA) cleanup levels for soil, groundwater, and surface water (Chapter 173-340 WAC);

- ▶ State surface water quality standards (Chapter 173-201A WAC) and federal Clean Water Act criteria (40 CFR 131, the National Toxics Rules);
- ▶ FPA Region 3 Screening Levels for soil, water, and fish/shellfish tissue (Smith, 1995);
- ▶ Plant and wildlife protection screening values for soils obtained from Will and Suter (1994) and Oak Ridge National Laboratory (1994); and
- ▶ Washington State Department of Ecology (Ecology) Sediment Management Standards (Chapter 173-204 WAC).

Risk-based screening levels incorporate conservative assumptions for protection of human health (e.g., one-in-a-million excess cancer risk, hazard quotient of one, residential and subsistence fisher exposure scenarios) and the environment (e.g., no or low adverse effects levels, generally chronic exposure scenarios, no mixing zone).

Analytes that exceeded the screening levels in any media were identified as COPCs at the Site. The COPCs identified at the Site include metals, PCBs, chlorinated pesticides, dioxins and furans, polynuclear aromatic hydrocarbons (PAHs), and petroleum hydrocarbons. A complete listing of the COPCs identified through the preliminary risk screening process is presented in Table 1.

Tables 2 through 11 summarize soil, groundwater, surface water, sediment, and tissue quality data collected at the Site, including data on the number of samples analyzed, their detection frequency and maximum detection, as well as exceedence frequency of screening levels. Tables 2 through 4 summarize soil quality data for the three source areas (Landfill, Fire Training, and Net Depot) identified at the Site. Tables 5 and 6 summarize groundwater quality data for the former Landfill Area (Surficial Fill unit) and the water supply aquifer (Outwash Channel Aquifer) near the former Fire Training Area, respectively. Tables 7 through 9 summarize surface water and seep discharge quality data for the three source areas of the Site, and Tables 10 and 11 summarize sediment and tissue quality data for Clam Bay.

A further evaluation of COPCs was performed as part of the risk assessment to identify the primary chemicals or chemical grouping posing a potential risk to human health and the environment. This evaluation included eliminating COPCs which were below naturally occurring background concentrations (e.g., certain metals). The baseline risk assessment (discussed below) identified the following twelve primary chemicals or chemical groupings at the site (out of the initial list of COPCs) associated with one or more media (soil, sediment, groundwater,

surface water, and tissue) at concentrations which exceed risk-based remediation goals or criteria:

Inorganics

- Arsenic
- Asbestos
- Cadmium
- Copper
- Lead
- Nickel
- Silver
- Zinc

Organics

- Polychlorinated biphenyls (total PCBs)
- Polychlorinated dibenzo-p-dioxins and dibenzofurans (dioxins/furans)
- 2,4-Dimethylphenol
- Vinyl chloride

Maximum concentrations for these twelve chemicals or chemical groupings detected in each Site medium are summarized in Table 12. Total Petroleum Hydrocarbon (TPH) concentrations are also included in Table 12. While only posing a marginal risk at the Site, TPH concentrations in soils at the Site exceed State of Washington Model Toxics Control Act (MTCA) soil cleanup goals.

For ease of discussion, the major findings of the RI/FS are presented for each of the following source areas, consistent with the Navy's historical Site use activities:

- ▶ Landfill and Clam Bay Sediments;
- ▶ Fire Training Area; and
- ▶ Net Depot and Manchester State Park.

Figure 2 illustrates the location of these areas and other major Site features.

6.1 Landfill and Clam Bay Sediments

The landfill encompasses an area of approximately 6 acres, with the majority of the debris in the uplands area and the eastern portion extending into the Clam Bay intertidal zone. The physical boundary of the landfill has been delineated by test pit observations of buried debris. The thickness of the upland landfill debris generally averages about 6 feet with some portions of the landfill ranging to 12 feet in thickness. Figure 3 presents a generalized geologic cross section through the Landfill (refer to Figure 2 for the cross section location). The upland debris is covered by a cap of clean sand and gravel which averages one foot in thickness. The intertidal landfill debris is exposed in a narrow strip along the shoreline, about 20 to 50 feet wide and ranging from 1 up to 8 feet thick. The total volume of the landfill debris (upland and intertidal) and cap material is approximately 70,000 cubic yards.

As shown on Figure 3, the landfill debris is underlain by a thin layer of surficial fill and beach deposits overlying a thick sequence of low permeability silt. A localized zone of saturation occurs within the landfill debris and surficial fill unit, associated with local precipitation recharge, surface water run-on to the landfill area, and tidal flushing. The low permeability silt acts as a natural barrier, preventing the downward movement of landfill leachate to the deeper groundwater zone. Recharge to the landfill ultimately mixes with leachate in the landfill and discharges as seeps along the intertidal zone.

Landfill wastes contain elevated concentrations of a variety of metal and organic chemicals including arsenic, cadmium, copper, lead, nickel, silver, zinc, PCBs, dioxins/furans, vinyl chloride, and asbestos, as shown in Table 2. Roughly half of the landfill soil samples analyzed by toxicity characteristic leaching procedure (TCLP) exceeded lead toxicity criteria. Erosion of landfill waste materials in the intertidal area of Clam Bay, due to tidal action, represents a continuing source of contaminants, primarily metals, PCBs, and dioxins/furans, to the marine environment.

The highest concentrations of chemicals of concern in the sediments and shellfish tissue, particularly metals and PCBs, were identified in areas immediately adjacent to the landfill toe. Constituent concentrations decline rapidly outside the landfill toe area. PCBs, metals (cadmium, copper, lead, mercury, and zinc), and dioxins were the primary chemicals identified in marine sediments (Table 10). Chemical analysis of marine tissue, including clams, geoduck, and sea cucumbers, were also performed. Tissue concentrations in Clam Bay were above reference site-adjusted screening levels for PCBs, dioxins, metals, and PAHs (Table 11).

Potential impacts to marine organisms were evaluated by performing laboratory bioassay tests using contaminated sediments collected at the Site. The bioassay results indicated moderate adverse effects to the existing benthic infauna within the intertidal area of Clam Bay.

Impacts to sediment quality within Clam Bay are largely limited to the uppermost layer of sediments. Two high-resolution coring profiles of PCBs indicate that the depth of contamination ranges from 0.3 to 0.7 foot, averaging 0.5 foot. A deeper accumulation of contaminated sediments exists in an isolated area of the intertidal zone. Offshore from the north end of the landfill (just south of the pier) is a localized (approximately 2,700-square-foot) depression with a thick (greater than 3-foot) accumulation of fine-grained sediment exhibiting elevated concentrations of PCBs, copper, zinc, and 2,4-dimethylphenol. This offshore feature (referred to as the "silt basin") may have resulted from removal

of an in-water structure, or from local current movement and sediment deposition patterns.

Seep discharges along the landfill toe, associated with surface water and precipitation recharge through the landfill as well as tidal flushing, result in the release of dissolved metals to the nearshore environment. The discharge to Clam Bay is fairly low, estimated to be in the range of 5 to 8 gallons per minute across approximately 800 feet of landfill shoreline frontage. Saturated conditions within the surficial fill and beach deposits beneath the landfill debris largely result from the local freshwater recharge and tidal inflow. Groundwater flow directions within the surficial fill unit is shown on Figure 4. The "groundwater" quality in this unit, summarized in Table 5, is indicative of leachate conditions beneath the landfill. Leachability tests (TCLP) of landfill debris samples indicated that metals within the debris are leachable and likely dissolve into recharge water infiltrating through the waste. Several metals (including copper, nickel, silver, and zinc) and low-level PCB concentrations (Table 7) were detected in tidal seeps discharging from the landfill. The seeps contain a component of non-saline groundwater and a component of seawater which, at high tide, flows into the beach deposits which underlie the landfill debris, backflushing out at low tide.

6.2 Fire Training Area

Historical activities at the Fire Training Area included fuel storage and firefighting training. The Fire Training Area previously included three simulator structures, only one of which (referred to as the "main simulator complex") is still standing. Accumulations of debris inside the main simulator complex contain elevated concentrations of dioxins/furans. The internal debris volume is estimated at approximately 200 cubic yards. Table 3 summarizes soil quality data for the Fire Training Area.

Significantly lower concentrations of dioxins/furans were also detected in the following media/locations outside the simulators:

- ▶ **Surficial Soil in the Immediate Vicinity of the Simulators.** The presence of dioxins/furans is likely associated with the fallout of ash or burning debris from the main simulator during training exercises. The depth of contamination appears to be less than one foot and is limited to several isolated areas near the corners of the simulator structures, as shown on Figure 8. Dioxin releases are not likely to have extended under the simulator structures, except through any possible floor cracks, if they exist. No sampling and analysis have been performed to verify this condition.

- **Pile of Demolition Debris and Soil Located about 500 Feet North of the Main Simulator Complex.** The demolition debris is associated with the former northern simulator at this location. The simulator rubble pile (Figure 8) has an estimated volume of approximately 120 cubic yards.

Soils in the vicinity of the main simulator complex also exhibit concentrations of total petroleum hydrocarbons (TPH), with concentration of up to 15,000 mg/kg as diesel and 7,700 mg/kg as oil. The TPH consists of a mixture of weathered diesel- and oil-range hydrocarbons. A number of petroleum-containing USTs were formerly located in this area, and several are known to have leaked. In addition, at least five concrete USTs still remain in-place. The remaining concrete USTs contain residual sludges. Chemical analysis of these sludges during the tank removal process, prior to the RI, indicated the presence of PCBs. The vertical extent of TPH-impacted soils ranged from near-surface to as much as 10 feet below grade.

Smaller areas of TPH concentrations were detected at four former fire training stations (i.e., smoldering pots and "Christmas trees") north of the main simulator complex, shown on Figure 8. These areas contained diesel- and oil-range hydrocarbons which permeated the upper several feet of soil. In addition, soil at the location of a former gasoline UST contained subsurface hydrocarbon concentrations in the gasoline range of up to 480 mg/kg.

The TPH-impacted soils within the former Fire Training Area are located near the Outwash Aquifer which is used by the adjoining Manchester Naval Fuel Depot and a local community for potable water supply. The general location and groundwater flow direction within the Outwash Aquifer is shown on Figure 4. The remedial investigation included extensive data collection and testing to evaluate the potential impact of the TPH on the Outwash Aquifer. Initial efforts included chemical analysis and leachability testing of TPH-impacted soils using the Synthetic Precipitation Leaching Procedure (SPLP). The empirical TPH soil-to-water partitioning ratios at the site range from 1,000:1 to 7,000:1, and average 5,000:1 (Table 13). These results indicate that the TPH is highly weathered, due to chemical and biological degradation over a 30-year-plus period since release, and largely consists of the heavy (very low aqueous solubility) petroleum fraction. The SPLP data indicate that the remaining petroleum constituents are not leachable. This conclusion is supported by shallow aquifer monitoring results, which were generally below screening levels for petroleum constituents. A summary of the groundwater quality in the Fire Training Area is presented in Table 5.

In addition, several pumping tests, using the Navy's water supply wells, were conducted to assess whether pumping the water supply wells would result in the

transport of petroleum constituents to the aquifer. Sampling of shallow groundwater beneath the TPH-impacted soils during active pumping did not identify any petroleum constituents, even at very low level detection limits. Consequently, the TPH-impacted soils do not pose a risk to nearby public and private water supply wells.

Diesel range hydrocarbons were detected at a concentration of 5.2 mg/L (and 20 mg/L in a duplicate sample) in one surface water sample collected from the outflow of a pipe discharging to a pond in the southern portion of the Fire Training Area. Based on a review of historical site plans, the pipe appears to be connected to a storm drain system and likely received TPH in runoff from roadways or parking lots at the NMFS lab. However, the exact source area of this pipe has not been determined.

6.3 Net Depot and Manchester State Park

Tables 4 and 9 summarize soil and seep discharge quality data for the Net Depot area. The analytical results for the Net Depot and Manchester State Park areas of the Site indicated limited exceedence of conservative risk-based screening criteria. Several metals with concentrations slightly elevated above the screening levels were detected in these areas, including arsenic (8.6 mg/kg), beryllium (0.8 mg/kg), copper (71 mg/kg), and zinc (231 mg/kg). Several surface water/seep samples in the Net Depot area also exceeded screening levels for dissolved copper (30.6 ug/L) and total cyanide (5 ug/L). These seeps appear to be associated with drain pipes which may receive storm water runoff from the parking lot areas.

7.0 SUMMARY OF SITE RISKS

CERCLA response actions at the Site, as described in the ROD, are intended to protect human health and the environment from current and potential future exposure to hazardous substances detected at the Site.

Baseline human health and ecological risk assessments were performed to assess Site conditions and to determine the need for cleanup. As set forth in the NCP, the risk assessment provides an understanding of the actual and potential risks to human health and the environment at the Site, in the absence of any future actions to control or mitigate these releases.

7.1 Human Health Risks

Detailed assessments of the risks to human health involve a five-step process: 1) identification of chemicals of potential concern; 2) determination of exposure to

the population(s) at risk; 3) assessment of contaminant toxicity; 4) quantitative characterization of site risk; and 5) evaluation of uncertainties associated with the overall risk assessment.

7.1.1 Chemicals of Potential Concern

The risk assessment evaluated chemicals detected in at least one sample at a concentration above the most conservative risk-based screening levels. These COPCs included seventeen metals and inorganics, ten hydrocarbons, four pesticides, PCBs, dioxin/furan congeners, and several miscellaneous organic chemicals. A listing of COPCs detected at the Site is presented in Table 1.

7.1.2 Exposure Assessment

The exposure assessment characterizes exposure scenarios, identifies potentially exposed populations along with pathways and routes of exposure, and quantifies contaminant exposure in terms of a chronic daily dose (i.e., milligrams of contaminant taken into the body per kilogram of body weight per day).

Consistent with recent EPA guidance, human health exposure scenarios evaluated in the risk assessment were developed based on reasonable assumptions about future land uses and human activities expected at the Site. Most of the Site is currently used by EPA and NMFS as an environmental laboratory facility. In addition, a small portion of the Site is used as a State Park. Based on input from the Manchester Annex Work Group, continued use of the Site for federal laboratories and a State Park was assumed in evaluating potential human health risks. Assuming future residential use at the Manchester Annex Site was considered unrealistic.

The conceptual model for chemical release, transport, and human exposure at the Site is presented on Figure 5, and exposure pathways are illustrated on Figure 6. Mechanisms for chemical release and exposure at the Site include the following:

- ▶ Direct contact with contaminated soils, sediments, and debris;
- ▶ Volatilization, dust emission, and inhalation of chemicals from contaminated surface soil;
- ▶ Solubilization, transport, and drinking water consumption of chemicals in groundwater;

- ▶ Surface water runoff and tidal erosion of surface soils and sediments into waterways; and
- ▶ Transport of contaminants to Clam Bay, bioconcentration and bioaccumulation through the food chain, followed by recreational or subsistence-level consumption of contaminated seafood.

EPA Superfund guidance recommends that reasonable maximum exposures be calculated in site risk assessments. Reasonable maximum exposure estimates are calculated using assumptions that result in higher than average exposures to ensure that the risk assessment results are protective of the reasonably maximum exposed individual. For this risk assessment, both average and reasonable maximum exposures (RME) were estimated using default exposure factors and calculation procedures described in EPA Region 10 risk assessment guidance. Average and upper 95th percent confidence limits (UCLs) of the arithmetic mean chemical concentrations detected at the Site were used to calculate the concentration terms used in the exposure assessment. If the estimated UCL exceeded the maximum detected concentration, the estimate defaulted to the maximum detected concentration.

An individual's exposure to chemicals through activities such as digging in the soil, or eating shellfish caught at the Site, was estimated assuming that current controls such as the existing landfill soil cover are not maintained into the future.

Currently, EPA prohibits shellfishing on its beaches, and staff working at the EPA and NMFS facilities presently obtain six or fewer meals per year from Clam Bay. This condition is partially the result of the relatively low edible clam biomass at the Site resulting from habitat limitations. However, on-site recreational and tribal subsistence harvesting of seafood within Clam Bay could increase in the future through habitat enhancement. Following the recommendations of the Washington State Department of Fish and Wildlife (WDFW) and the Suquamish Tribe, the risk assessment evaluated recreational and subsistence harvesting rates possible under a future habitat enhancement scenario. Reasonable maximum harvesting rates assumed in the exposure assessment were 22 meals (3.4 kilograms [kg]) per year and 150 meals (23 kg) per year for recreational and subsistence consumption, respectively.

7.1.3 Toxicity Assessment

Toxicity and risk assessments vary for different chemicals depending upon whether carcinogenic and non-carcinogenic risks are being evaluated. The toxicity criteria used in risk assessments are based on the endpoints observed from laboratory or epidemiological studies with the chemicals. Carcinogenic

risks are calculated using toxicity factors known as cancer potency factors (CPFs), while non-carcinogenic risks rely on reference doses (RfDs). When available, toxicity factors used in this risk assessment were obtained from EPA's Integrated Risk Information System (IRIS; EPA, 1995a). In the absence of verified toxicity factors on IRIS, other EPA sources were consulted (Dollarhide, 1992; and EPA, 1985, 1989, 1993, and 1995b).

Reference Doses (RfDs). Reference doses are used to quantitatively evaluate non-carcinogenic toxicity of a specific chemical. Reference doses are established by EPA at concentrations below which adverse health effects are not known to occur. In general, the RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

Cancer Potency Factors (CPFs). The toxicity of potential human carcinogens are evaluated differently by EPA. It is assumed for carcinogens that no threshold concentrations exist below which adverse effects may not occur. Probabilistic methods based on chemical-specific dose-response curves are used to establish slope factors, which are then used to quantify potential risks from exposure to carcinogens. Although dose-response curves are generated by EPA using human data when those data are available, dose-response curves are often generated in laboratory studies using high chemical concentrations. The dose-response curve is fitted to a linearized multi-stage model that extrapolates the slope of the curve from high experimental concentrations to low concentrations at which people are typically exposed. The final CPF is based on the upper 95th percentile UCL of the extrapolated slope of the dose-response curve.

Inorganic Lead. The methods used to assess exposure, toxicity, and risk are different for inorganic lead than for other contaminants. A great deal of information on the health effects of lead has been obtained through decades of medical observation and scientific research. Some of the effects resulting from exposure to inorganic lead compounds are associated with increased blood lead. However, these effects may occur at blood lead levels so low as to be essentially without a threshold. Currently, EPA has considered it inappropriate to develop either an RfD or CPF for inorganic lead.

EPA has developed and is using an Integrated Exposure Uptake Biokinetic model of lead exposures which has been used in lieu of verified RfD and CPF criteria. The model has been applied primarily to residential sites, though limited applications have been developed for non-residential areas were considered in this risk assessment. Consistent with model results and state and federal cleanup guidelines, soil lead concentrations below 1,000 milligrams per kilogram (mg/kg)

were considered protective in non-residential areas. This value was used as a risk-based soil concentration benchmark criterion for assessing elevated lead concentrations detected in soil at the site. Lead concentrations of up to 56,000 mg/kg have been detected within the Landfill Area of the Site (Table 2).

TPH. Elevated total petroleum hydrocarbon (TPH) concentrations up to 15,000 mg/kg have been detected in the Fire Training Area of the Site (Table 3). However, no verified oral toxicity factors have been derived for TPH mixtures. EPA has developed provisional oral RfDs and CPFs for several TPH mixtures including gasoline and diesel fuels based on extrapolations of inhalation toxicity, since few other data were available. In making this provisional determination, EPA applied conservative uncertainty factors to address some of the possible bias associated with route-to-route extrapolations. The provisional TPH toxicity criteria used in this risk assessment are currently under EPA review.

7.1.4 Risk Characterization

For risk characterization purposes, the entire Site was considered in aggregate, utilizing UCL exposure point concentrations within different areas of the Site to derive Site-wide RMEs and risks. For cleanup alternative evaluation purposes, the Site was divided into three different remedial action areas characterized by different waste characteristics and response actions (see Figure 2 and Section 9.0 below).

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to specific COPCs. Cancer potency factors are multiplied by the estimated intake (exposure) of a potential carcinogen to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The EPA's current guideline for determining whether the reasonable maximum cancer risk estimated for a given hazardous site exceeds "threshold" cleanup action levels is 10^{-4} (1 in 10,000 probability of developing cancer resulting from lifetime exposure to a carcinogen). By comparison, the general target for lifetime cancer risks under MTCA is 10^{-5} . Under both programs, however, a cancer risk goal of 10^{-6} is generally used where practicable.

Non-carcinogenic risk is evaluated by dividing the daily dose resulting from site exposure by the estimate of acceptable intake (or reference dose) for chronic exposure. If the ratio between these values (termed the hazard quotient) is less than 1, then the exposure does not exceed the protective level for that particular chemical. Conversely, hazard quotient values greater than 1 indicate a potential risk to human health. Under both the CERCLA and MTCA programs, if the sum of all chemicals' hazard quotients for an exposure medium (termed the hazard

index) is greater than 1.0, then there may also be a concern for potential health effects.

Potential health risks to individuals under the following scenarios were evaluated:

- ▶ An on-site worker;
- ▶ A subsistence consumer of shellfish; and
- ▶ An occasional site visitor (including children).

Both the on-site worker and occasional site visitor (child) had similarly high calculated health risks, though the visitor scenario had slightly higher risk estimates. Calculated average and reasonable maximum exposure cumulative cancer risks and hazard indices for the three different exposure scenarios are summarized in Table 14. Under RME conditions, a cumulative Hazard Index of 1,000 and a total cumulative lifetime cancer risk of 1×10^{-3} were calculated based on the summation of all chemicals and potential pathways at the Site. Calculated health risks to the on-site worker and occasional site visitor are primarily associated with potential skin contact and incidental ingestion of waste materials containing elevated metal and dioxin/furan concentrations. High concentrations of these compounds are restricted to subsurface landfill waste materials and simulator debris. In addition, lead concentrations detected within the landfill areas exceeded the risk-based benchmark concentration for non-residential sites of 1,000 mg/kg. Based on the risk assessment, soil containing elevated TPH concentrations was not identified as a threat to human health.

Potential health risks for the subsistence consumer of shellfish, while lower, were still above concentrations targeted by the State of Washington cleanup program (MTCA; Table 14). Health risks to the subsistence consumer of shellfish primarily result from consumption of PCBs in shellfish collected from the intertidal area of Clam Bay.

7.1.5 Uncertainty in the Human Health Risk Assessment

The overall uncertainty in the human health risk characterization is represented in part by the differences between the average and reasonable maximum risk estimates presented in Table 14. A semi-quantitative sensitivity analysis was performed to identify individual exposure and toxicity assessment assumptions which contributed most to the overall uncertainty in the risk estimates. The sensitivity analysis identified five principal areas of uncertainty:

- ▶ Representativeness of key soil exposure concentration terms;
- ▶ Dermal (skin contact) exposure assumptions and extrapolations;

- ▶ Possible access to the Site by an occasional site visitor;
- ▶ Toxicity assessment of PCB congeners; and
- ▶ Risk characterization using cancer risk models.

Most assumptions incorporated into the baseline risk assessment were intentionally conservative so that the risk assessment would be more likely to overestimate rather than to underestimate risk. However, in some cases the nature of the uncertainty is such that the impact of the assumptions could result in an overestimate or underestimate of Site risk.

7.2 Ecological Risks

An ecological risk assessment was performed to characterize current and potential future environmental threats at the Site, particularly to valuable ecological resources such as Clam Bay habitats. The assessment, which addressed both aquatic and terrestrial exposures, incorporated a two-tiered approach. In the Tier I assessment, concentrations of chemicals of potential concern were compared to toxicological benchmarks which represent concentrations of chemicals in environmental media (i.e., soil, water, sediment, and biota) that are presumed to be non-hazardous to the surrounding biota. Tier I relied on chemical concentration measurements and conservative toxicity benchmark criteria available in the literature. Based on Tier I results, the need for and scope of more definitive Tier II biological evaluations were determined. Tier II incorporated Site-specific information as appropriate, and included biological sampling to support or refute the Tier I findings.

The ecological assessment identified metals, PCBs, and furans in the Landfill Area which have the potential to impair microbial and soil processes, inhibit plant growth, and/or could result in toxicity to earthworms and sensitive small rodents which inhabit the Site. Several of these metals are also currently discharging from the landfill shoreline area at concentrations which could result in acute and/or chronic toxicity to sensitive marine life. Because of tidal currents and associated mixing processes, the extent of elevated metal concentrations within the shoreline area of Clam Bay is likely limited to the immediate vicinity of the seepage face and seepage channels.

Metals, PCBs, and 2,4-dimethylphenol were detected in intertidal sediments of Clam Bay at concentrations which could result in toxicity to sensitive marine infauna. Confirmatory sediment bioassays generally confirmed this condition. Further, elevated metals, PCB, and furan concentrations detected in intertidal shellfish could pose a risk to wildlife which derive their entire diet from prey obtained from Clam Bay. Overall, potential risks to the environment at the Site are limited to the Landfill Area and to the intertidal area of Clam Bay.

Detection limits for mercury, PCBs, DDT, aldrin, and dioxins in seeps were not sufficient to evaluate risk to marine aquatic life. However, these chemicals were incorporated in the ecological risk assessment at one-half detection limit values. Some other chlorinated pesticides were also undetected at elevated detection limits, but were not incorporated in the risk assessment, potentially causing a slight underestimate of the overall risk to aquatic life. Similarly, detection limits for several chlorobenzene compounds were not sufficient to compare with ecological sediment criteria. However, Tier II bioassay testing of Site sediments provided a direct measure of cumulative risk from all Site contaminants.

8.0 REMEDIAL ACTION OBJECTIVES

8.1 Need for Remedial Action

The results of the baseline human health and ecological risk assessments indicate that potential long-term risks associated with soil and debris in the Landfill and Fire Training Areas, and sediment contamination in Clam Bay, are above acceptable concentrations defined under both the state (MTCA) and federal (Superfund) regulations. Actual or threatened releases of hazardous substances from this Site, if not addressed by remedial actions, may represent a current or potential threat to public health, welfare, or the environment. Consistent with the NCP and EPA policy, remedial action is warranted to address these potential risks.

This Record of Decision makes a distinction between cleanup levels and cleanup goals. Cleanup levels represent specific concentration limits to protect human health and the environment, as defined by the Site-specific risk assessment and in applicable or relevant and appropriate regulations (ARARs). Table 15 presents a listing of Site-specific cleanup levels and cleanup goals. Remedial alternatives were developed for the Manchester Annex Site to attain these cleanup levels.

In contrast, cleanup goals are conceptual targets for additional Site-specific cleanup of two key contaminants: TPH and PCBs. The soil cleanup goal for diesel and oil-range TPH as defined by MTCA is 200 mg/kg. However, because of the low leachability and low risk associated with TPH at the site, attainment of this goal is not necessary to provide protection of human health and the environment. Nevertheless, where practicable, additional operations and maintenance controls may be appropriate to further reduce TPH-related risks.

Although sediment cleanup levels for the Manchester Annex Site were based on the existing recreational exposure condition, sediment and tissue cleanup goals for PCBs were developed assuming a possible long-term subsistence fishing use of Clam Bay (Table 15). Both sediment and shellfish concentrations are predicted to decline rapidly following remediation to the recreational-based cleanup levels. Risks associated with subsistence fishing can be controlled by implementing temporary limitations on subsistence-level consumption during the initial recovery period. In this case, monitoring would be performed to verify attainment of the cleanup goals.

8.2 Landfill Area and Clam Bay

The human health and ecological risk assessment identified potential threats associated with a variety of metal and organic chemicals detected within the Landfill Area. Based on the risk assessment, the following remedial action objectives were developed for the Landfill and Clam Bay areas of the Site:

- ▶ Prevent human and wildlife contact with solid wastes and soils/sediments in the landfill;
- ▶ Prevent fugitive dust emissions containing asbestos;
- ▶ Prevent shoreline erosion of landfill wastes;
- ▶ Reduce solubilization and migration of landfill contaminants to Clam Bay by eliminating seeps or by improving the quality of the seeps so that they meet water quality criteria;
- ▶ Reduce concentrations of metals, PCBs, and 2,4-dimethylphenol to below cleanup levels for sediments in the biologically active zone (0 to 10 cm depth); and
- ▶ Prevent subsistence-level harvesting of shellfish in the nearshore areas of Clam Bay until the shellfish are determined to be safe to consume at a subsistence level.

Instead of establishing numerous chemical-specific cleanup levels for soils and solid wastes present within the upland and shoreline areas of the Site, the presumptive remedy for military landfills (capping) was first applied to the Site to determine if this presumptive remediation approach could achieve most or all of the identified remedial action objectives. The area to be contained within the cap was initially determined based on the physical extent of landfill debris. The extent of solid wastes at the Site is depicted on Figure 7.

To evaluate the protectiveness of the presumptive remedy applied to the Landfill Area, the residual risk associated with soils and sediments located immediately

adjacent to the landfill area (i.e., outside the footprint of the presumed capping area) was calculated using methodologies equivalent to those used in the baseline risk assessment. The results of this assessment reveal that, even under RME conditions, risks to on-site workers, occasional site visitors, and terrestrial wildlife would be below both MTCA and CERCLA risk goals (i.e., cancer risks below 1×10^{-5} , Hazard Index below 1, and no identified risk to the upland environment). The presumptive remedy is therefore adequately protective of upland exposure conditions within the Landfill Area.

While the presumptive remedy of landfill capping would also achieve substantial risk reductions for existing or potential receptors in Clam Bay (i.e., aquatic life and subsistence fishers), this action may not be sufficient by itself to achieve all of the identified remedial action objectives within the marine environment. Accordingly, chemical-specific cleanup levels and cleanup goals were developed for aquatic exposure pathways which will achieve overall risk management goals as follows:

- ▶ A cumulative cancer risk goal under future RME conditions of 1×10^{-5} (MTCA Method C criterion), considering combined seafood ingestion, sediment contact, and incidental sediment ingestion pathways;
- ▶ A cumulative hazard index under future RME conditions of 1, also based on a cumulative pathway analysis;
- ▶ No identified risk to aquatic biota and other wildlife; and
- ▶ Compliance with applicable or relevant and appropriate requirements (ARARs), including State of Washington surface water quality standards (Chapter 173-201A WAC) and sediment management standards (Chapter 173-204 WAC).

The cleanup levels and cleanup goals relevant to the Landfill and Clam Bay areas of the Site are summarized in Table 15.

8.3 Fire Training Area

Besides the Landfill/Clam Bay area, the only other area of the Site which poses an identified risk to human health and the environment is the Fire Training Area (Figure 8). The risk assessment identified potential threats associated with dioxin/furan congeners detected primarily within the simulator areas. Based on the risk assessment, the following remedial action objectives were developed for the Fire Training area:

- ▶ Prevent human and wildlife contact with simulator debris and soils containing dioxin/furan concentrations greater than the cleanup level; and
- ▶ Minimize solubilization and migration of TPH into groundwater.

As discussed above, the Site is not an existing or potential future residential site, nor does the Site qualify as an industrial site under the MTCA cleanup regulation. Chemical-specific cleanup levels and cleanup goals were developed for this upland area of the Site using the baseline risk assessment along with the following risk management goals:

- ▶ A cumulative cancer risk goal under future RME conditions of 1×10^{-5} (MTCA Method C criterion), considering cumulative soil contact, incidental soil ingestion, inhalation, and drinking water pathways;
- ▶ A cumulative hazard index under future RME conditions of 1, also based on a cumulative pathway analysis; and
- ▶ Compliance with ARARs including State of Washington MTCA Method C soil cleanup levels for non-industrial sites (WAC 173-340-740).

The cleanup levels and cleanup goals relevant to the Fire Training Area are summarized in Table 15. A soil cleanup goal for TPH (as diesel) was established for this area of the Site based on the MTCA Method A (routine) cleanup level. However, since the site specific risk assessment and leachability testing indicated only a low risk from TPH, no chemical-specific cleanup level is necessary.

8.4 Net Depot and Manchester State Park

Baseline risks within the former Net Depot (current EPA laboratory) and Manchester State Park areas of the Site were determined to be below both human health and environmental risk management goals (i.e., cancer risks below 1×10^{-5} , Hazard Index below 1, and no identified risk to the upland environment). Consolidation of relatively small quantities of solid waste from the Manchester State Park to the current EPA property is anticipated as a result of the presumptive remedy (landfill capping), primarily because the presence of a utility corridor which runs along the property boundary may interfere with remediation if the wastes are not relocated. (Construction of the cap over the utility corridor should be avoided. As an alternative to waste consolidation, the utility corridor may be relocated.) Accordingly, no further remedial action objectives were developed for the Net Depot and Manchester State Park areas of the Site.

8.5 Groundwater

Currently, water supply for the NMFS and EPA facilities is provided by an off-site source. With the exception of the Outwash Aquifer, near the Fire Training Area at the southern edge of the Site, groundwater present throughout the Site is not a current or potential source of water supply. No chemicals have been detected at concentrations above risk-based and aesthetic screening levels in shallow groundwater below the Fire Training Area or within the Outwash Aquifer. The Fire Training Area is the only area at the Site which occurs near the water supply aquifer (Outwash Aquifer). The low potential risk to human health associated with groundwater at the Site was also confirmed by the site-specific risk assessment (cancer risk less than 10^{-6} ; hazard index less than 0.3). Accordingly, no remedial action objectives were developed for Site groundwater, outside of the seep cleanup levels applicable to the landfill shoreline area (see Table 15).

8.6 Remediation Areas and Volumes

Areas exceeding soil and sediment cleanup levels in the Landfill/Clam Bay portion of the Site are shown on Figure 7. Areas exceeding soil cleanup levels and cleanup goals in the Fire Training Area are shown on Figure 8. (The Net Depot and Manchester State Park areas of the Site comply with all cleanup levels.) Site-wide area and volume estimates for all media exceeding soil and sediment cleanup levels are provided in Table 16. The entries in this table reflect further refinement of the areas and volumes presented in Table 3-3 of the Feasibility Study.

9.0 DESCRIPTION OF ALTERNATIVES

Various cleanup alternatives ranging from no action to complete removal/treatment of contaminated materials were identified and evaluated in the Feasibility Study (FS). Area-specific subsets of these alternatives were considered in the Proposed Plan, as discussed below.

9.1 Alternatives for the Landfill and Clam Bay Sediments

Of the six alternatives evaluated in the FS for cleanup of the Landfill and Clam Bay sediments, the following four were considered in the Proposed Plan:

- (1A) No Action (FS Alternative A1).

- (2A) Capping of Upland Landfill, Armoring over Intertidal Debris, and Placement of a Thin Cap over Remaining Impacted Sediments (FS Alternative A2).
- (3A) Capping of Upland Landfill, Excavation of Intertidal Debris and Placement of Design Fill, and Placement of a Thin Cap over Remaining Impacted Sediments (FS Alternative A5).
- (4A) Excavation/Dredging, Limited Treatment and Off-Site Disposal of All Landfill Debris, Soils, and Impacted Sediments (FS Alternative A6).

Descriptions of these four alternatives are presented below.

Alternative 1A—No Action. The No Action Alternative provides a baseline against which to compare the other alternatives to evaluate their effectiveness. Under this alternative, the Landfill and Clam Bay sediments would be left as they currently exist.

Alternative 2A—Capping of Upland Landfill, Armoring over Intertidal Debris, and Placement of a Thin Cap over Remaining Impacted Sediments. This alternative includes capping the upland portion of the Landfill, placing a hydraulic cutoff system upslope of the cap, placing a rock and cobble armor over the portion of the Landfill that extends into Clam Bay, and placing a thin cap over impacted sediments in Clam Bay.

Prior to cap construction, any solid waste located west of the utility corridor which runs along the EPA/Manchester State Park property boundary would be excavated and placed on the remaining upland landfill area. (Alternatively, the utility corridor could be relocated to outside the solid waste area.) The cap would be designed to meet state Minimum Functional Standards requirements and be consistent with the long-term plans for the property. The hydraulic cutoff system would keep groundwater and surface water from entering the Landfill along its upslope edge. Figure 9 shows the approximate areal extent of the landfill cap and hydraulic cutoff system.

Armoring of the landfill areas lying within the intertidal zone of Clam Bay would prevent further erosion of the landfill waste and provide a physical barrier to keep people and wildlife away from the debris. Figure 10 shows a schematic cross section of the armor layer. It may be 2 to 3 feet thick and would be filled with finer grained soils to provide a suitable environment for marine organisms. The armor layer would raise the elevation of the beach, causing an outward (seaward) shift in the high water line, and resulting in the loss of up to one acre of existing aquatic area. Based on input from the Manchester Site RI/FS Work

Group, measures to mitigate the loss of aquatic habitat would need to be considered as part of this alternative.

Prior to placement of the armor layer, a cap consisting of clean sediments or similar material would be placed over the silt basin sediments to isolate them from the intertidal environment. Sufficient cap material would be placed to fill the existing depression flush with the surrounding mudline (nominal 2-foot cap thickness).

Rows of clean sediment (windrows) would be placed over sediments exceeding sediment cleanup levels in the intertidal zone of Clam Bay which are not covered by the armor layer or silt basin cap. Tide and wind forces would spread the clean sediment out naturally and evenly over time. Remaining sediments with low concentrations of PCBs (exceeding the cleanup goal but posing minimal risk) are expected to recover rapidly once the source of contamination, erosion of the landfill waste, is eliminated. The natural recovery of these sediments, without the thin layer capping of sediments exceeding the sediment cleanup levels, was predicted to occur largely by burial and resuspension processes, based on modeling performed during the RI/FS. The addition of clean sediment in those areas exceeding the sediment cleanup levels should enhance the recovery of these remaining sediments through burial processes.

Long-term land use restrictions to prevent activities which could damage the cap, and a cap maintenance program, would be implemented. Potential construction impacts to the freshwater wetlands adjacent to the southern edge of the landfill (and to the potential emerging wetlands on the landfill area itself) would be addressed during final design. Restrictions on subsistence-level shellfish harvesting would apply until the Washington State Department of Health and the Suquamish Tribe determine that the shellfish are safe for subsistence-level harvesting. Unacceptable human health risks of consuming shellfish were found only at subsistence consumption rates (which are considerably higher than recreational consumption rates) of shellfish from tidelands adjacent to the Landfill and Fire Training Area. Sediment and tissue cleanup goals are predicted to be met 3 to 5 years after remedial construction is completed. Sediment and shellfish tissue in Clam Bay would be monitored periodically by the Corps to track recovery.

Any seeps observed during low tides would also be monitored for water quality. Based on preliminary analysis, placement of the armor layer, installation of the hydraulic cutoff system, and capping of the upland landfill would likely reduce the metals concentrations in seep discharge to below cleanup levels. Seep discharge would be further evaluated as part of the final design.

Alternative 3A—Capping of Upland Landfill, Excavation of Intertidal Debris and Placement of Design Fill, and Placement of a Thin Cap over Remaining Impacted Sediments. This alternative is similar to Alternative 2A described above in terms of capping of the upland Landfill, except that landfill debris in the intertidal zone would be excavated and placed on the upland Landfill prior to capping. The objective of this alternative is to minimize the impact to the aquatic habitat and maximize long-term beach stability. The excavation backfill would include a "design fill" component to help achieve water quality criteria in the seeps by reducing the flux of contaminants leaching from landfill materials (without altogether eliminating tidal exchange), and enhancing tidal dispersion and seawater mixing. The backfill must also provide erosion protection and the best possible habitat for marine organisms. The areal extent of the backfill would be limited to the pre-excavation footprint of the landfill wastes.

Figure 11 shows the conceptual design of the excavation backfill used in the FS for cost estimating purposes. It was assumed that the silty sand layer beneath the intertidal debris would be excavated along with the debris itself, so that the design fill material could be keyed into the underlying sandy silt. However, design of the excavation and backfill requirements under this alternative, including the need to excavate the silty sand layer, would be determined during the remedial design phase.

Excavation of the intertidal landfill debris (volume estimated at 7,000 to 10,000 cubic yards) is expected to be difficult because of the presence of submarine nets and the agglomerated nature of the debris. Special equipment may be required, including hydraulic shears and torches, to facilitate debris excavation and size reduction to allow placement/compaction in the upland landfill. Protective measures such as a temporary dike would be constructed offshore to prevent inundation at high tide and minimize the potential for drainage of landfill runoff and suspended sediment into Clam Bay during excavation/construction activities. The same land use restrictions, cap maintenance, restrictions on shellfish harvesting, and sediment/tissue monitoring as in Alternative 2A would apply. Sediment and tissue cleanup goals are predicted to be met 3 to 5 years after remedial construction is completed.

Alternative 4A—Excavation/Dredging, Limited Treatment, and Off-Site Containment of All Landfill Debris, Soils, and Impacted Sediments. In this alternative, all landfill debris (both intertidal and upland) would be excavated and disposed of in an approved off-site landfill. During the RI/FS investigation, roughly half of the landfill soil samples analyzed by TCLP failed for lead, indicating that a large fraction of landfill materials may be characterized as hazardous waste and, therefore, require special handling and treatment before disposal.

A very large volume of soil/debris would need to be excavated in this alternative. As with the intertidal debris, upland debris is expected to be difficult to excavate. The uplands excavation area would be restored by backfilling with clean imported fill and revegetating. The intertidal excavation would be backfilled with cobble and habitat material.

All Clam Bay sediments exceeding the cleanup levels would also be removed and disposed of in an off-site landfill. No long-term monitoring would be necessary for Alternative 4A.

It is estimated that Alternative 4A would require more than 2 years of field implementation. By contrast, construction in Alternatives 2A and 3A could likely be completed in a single construction season.

9.2 Alternatives for the Fire Training Area

Of the five alternatives evaluated in the FS for cleanup of the Fire Training Area, the following three were considered in the Proposed Plan:

- (1B) No Action (FS Alternative B1);
- (2B) Removal of All Dioxin-Contaminated Materials and In-Place Closure of USTs (FS Alternative B3).
- (3B) Removal of USTs and All Petroleum- and Dioxin-Contaminated Materials (FS Alternative B5).

Descriptions of these three alternatives are presented below.

Alternative 1B—No Action. The No Action Alternative provides a baseline against which to compare the other alternatives to evaluate their effectiveness. Under this alternative, the USTs and all petroleum- and dioxin-contaminated materials would be left in-place.

Alternative 2B—Removal of All Dioxin-Contaminated Materials and In-Place Closure of USTs. In this alternative, debris contained in structures within the main simulator complex with high concentrations of dioxin would be transported for disposal in an approved RCRA hazardous waste landfill. Limited areas of lower concentration dioxin-impacted soil outside the main simulators and soil/debris located north of the simulators would be excavated and disposed of in an approved off-site landfill. Soils beneath the simulators would be sampled and analyzed only if evidence of potential leakage through the

simulator structures is identified. The structures would be demolished if needed to complete removal of dioxin-impacted soils.

USTs in the Fire Training Area would be closed in-place following state UST closure requirements. Piping systems and a small volume of TPH-impacted soils excavated incidentally along with the piping, would be disposed of off site. To address remaining soils with TPH concentrations greater than the Site cleanup goal (200 ppm), there would also be restrictions and guidelines established for activities which may disturb areas where these soils are left in-place.

Alternative 3B—Removal of USTs and All TPH- and Dioxin-Contaminated Materials. Similar to Alternative 2B, this alternative includes excavation and off-site disposal of all dioxin-contaminated soil and debris.

Instead of being closed in-place, USTs would be removed and disposed of off site using conventional methods. In addition, soils with TPH concentrations greater than the Site cleanup goal would be excavated and biologically treated (via landfarming) on Site to achieve the cleanup goal. Structures in the immediate vicinity of the TPH-impacted soils (including the fire training stations and the main simulator complex) would be demolished and removed from the Site.

Implementation of Alternatives 2B and 3B could be completed in a single construction season.

9.3 Alternatives for the Net Depot and Manchester State Park

"No Action" is the only alternative considered in the Proposed Plan for the Net Depot and Manchester State Park areas of the Site, since these areas were not identified as posing a risk to human health or the environment. [As discussed in Section 8.4, the small portion of the landfill located on Manchester State Park property will be addressed under the presumptive remedy (landfill capping)]. This alternative would result in the Net Depot and Manchester State Park areas of the Site being left in their current condition.

10.0 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

Each of the remediation alternatives discussed above were evaluated against the nine criteria specified by the NCP. The nine criteria include:

- ▶ Two threshold criteria (overall protection of human health and the environment, and compliance with ARARs), which must be met for an alternative to be selected;
- ▶ Five balancing criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost) for comparing and choosing a preferred alternative, and
- ▶ Two modifying criteria (state acceptance and community acceptance) which are factored into selection of the final cleanup action.

The following sections discuss and compare remediation alternatives relative to the above criteria.

10.1 Evaluation of Landfill and Clam Bay Alternatives by Criteria

Overall Protection of Human Health and the Environment. Alternatives 2A, 3A, and 4A are protective of human health and the environment in terms of reducing the risk of impacts from landfill contamination. Site risk reduction is achieved in Alternatives 2A and 3A primarily by isolating impacted media from human contact and the environment; however, Alternative 2A would result in the loss of up to 0.9 acre of aquatic habitat. In Alternative 4A, it is achieved by removing impacted media from the Site.

No Action (Alternative 1A) is not protective of human health or the environment, the thus will not be considered further in this evaluation.

Compliance with ARARs. Alternatives 3A and 4A, which include removal of the intertidal debris and excavation and removal of the entire landfill, respectively, comply with all ARARs. There was considerable discussion within the Manchester Work Group on whether Alternatives 2A will achieve compliance with all ARARs. One areas of uncertainty with Alternative 2A, raised by the state, is the compliance of seep discharges at the landfill toe with surface water quality criteria. Although preliminary evaluations of the expected performance of Alternative 2A indicated that landfill capping and other hydraulic controls included in this alternative would be more likely than not to achieve compliance with surface water quality criteria at the seepage discharge point(s), this condition could not be fully evaluated without detailed modeling, which was beyond the scope of the FS.

In addition, the natural resource agencies in the Work Group articulated their position that habitat mitigation would be necessary under Alternative 2A to

compensate for the loss of aquatic habitat function and area. Although preliminary on-site mitigation options were identified which would partially restore historical salt marsh habitat within this area and create more aquatic area than would be lost, the resource agencies determined that other remedial options such as Alternative 3A provided a practicable alternative to Alternative 2A which could obviate the need for any compensatory mitigation. Because the Washington State Hydraulic Code Rules (Chapter 220-110 WAC) set forth priorities to avoid or minimize aquatic habitat impacts wherever possible, and allow consideration of compensatory mitigation only when impacts are unavoidable, the resource agencies concluded that selection of Alternative 2A may not be consistent with the state ARAR.

The Manchester Work Group was not able to reach an agreement on what constituted the need for or an appropriate level of mitigation (e.g., ratio of replacement habitat to lost or impacted habitat), in part because there is currently no clear state or federal regulatory criteria for determining the need for and level of mitigation for actions taken at CERCLA sites. Consequently, Alternative 2A has a greater level of uncertainty with respect to ARAR compliance, possibly with attendant cost and schedule impacts.

Long-Term Effectiveness and Permanence. The landfill cap and upgradient hydraulic cutoff system included in Alternatives 2A and 3A prevent direct contact exposure to upland landfill debris and effectively isolate the debris from precipitation and groundwater infiltration. Provided these systems receive periodic maintenance, they are expected to achieve long-term protection.

The landfill toe remedial components of Alternatives 2A and 3A both prevent direct contact exposure to landfill debris in the intertidal zone. However, Alternative 3A does provide some consolidation of the landfill waste by excavating the landfill toe and placement in the upland portion of the landfill. Alternative 3A is also designed to provide sufficient isolation of the debris from intertidal flushing such that cleanup levels are achieved at the seeps. Both Alternatives 2A and 3A appeared to be generally similar in terms of their permanence, relative to susceptibility to beach erosion, though additional design analyses would be necessary to fully evaluate this condition. Excavation and placement of design fill under Alternative 3A would afford greater waste isolation in a severe beach erosion event based on the greater thickness of clean fill materials.

Alternative 4A provides long-term effectiveness and permanence at the Site by removing all materials exceeding cleanup levels. A large portion of these materials would be contained off site.

Reduction of Toxicity, Mobility, or Volume through Treatment. Alternatives 2A and 3A do not include any treatment to reduce toxicity, mobility, or volume of site contaminants. In Alternative 4A, all characteristic Dangerous Waste materials from the landfill undergo on-site stabilization to reduce the potential for metals leaching. The portion of the landfill debris which is likely to characterize as Dangerous Waste is unknown.

Short-Term Effectiveness. Short-term effects associated with the construction/implementation phase of a remedial alternative include impacts to the environment, to construction workers, and to the adjacent community (including employees working at the EPA/Ecology Environmental Laboratory and the NMFS Field Station). Capping of the upland landfill (Alternatives 2A and 3A) is expected to have minimal short-term impacts. The existing landfill cover soil provides protection against exposure to upland landfill debris. Dust control measures during construction would be important to minimize short-term inhalation risks and to minimize airborne particulate releases and associated quality control problems within the environmental laboratories. The general public does not have access to the Landfill Area. An alternative access route to the EPA laboratory may need to be provided during construction activities.

The major potential impact associated with construction in the intertidal zone is short-term degradation of the aquatic environment. The impacts of construction activities in Alternative 2A, which include placement of protective armor over the landfill toe, are expected to be relatively minor. Intertidal construction activities in Alternative 3A are more extensive, including debris excavation at the landfill toe. Short-term impacts associated with excavation of landfill debris in the intertidal zone include disturbance of aquatic habitat during placement and removal of a tidal dike and debris removal, and potential release of contaminants associated with landfill debris to the environment. Measures taken to minimize short-term impacts to the aquatic environment would include working during low tides to the extent possible, and placement of a temporary dike during debris excavation to prevent erosion of cut faces into Clam Bay.

Excavation of landfill debris in Alternatives 3A and 4A would subject construction workers to significantly higher constituent concentrations compared to Alternative 2A due to the increase level of waste excavation and disposal. Exposure potential would be largest by far in Alternative 4A, where all landfill debris would be excavated.

Implementability. The construction components of Alternative 2A require only conventional methods and equipment, and are readily implemented. However, the implementability of mitigation measures required with Alternative 2A are uncertain, since the type and extent of mitigation have not been determined.

Alternative 3A requires partial excavation of the landfill (the intertidal portion only), and Alternative 4A requires complete excavation of all landfill debris. Landfill debris is expected to be difficult to excavate because of submarine nets and agglomerated wastes reported to be present. Size reduction of the excavated debris may also be difficult using conventional methods. Field trials of excavation and/or size reduction techniques may be required prior to remedial design of an action which includes excavation of landfill debris.

The on-site treatment (stabilization), transportation, and disposal components of Alternative 4A would all likely present major implementation hurdles based on the large quantity of material involved. An estimated 140,000 tons of material would be transported off the Site. Even assuming that only a small fraction of excavated materials would require stabilization, the construction phase of Alternative 4A would likely require several years to implement.

Alternatives 2A through 4A involve dredge and fill activities in the Clam Bay intertidal zone. These activities would require coordination with several government agencies, leading to possible implementation difficulties and delays.

Construction in Alternatives 2A through 4A would impact the only access road to the EPA/Ecology Environmental Laboratory. Provision must be made for access to these facilities. The institutional controls required in Alternatives 2A and 3A are considered easy to implement.

Cost. The estimated cost of each remediation alternative for the Landfill and Clam Bay is shown below:

Alternative	Initial Costs	Present Worth of Annual O&M Costs	Present Worth of Total Costs
1A	\$0	\$0	\$0
2A	\$3,100,000	\$370,000	\$3,500,000
3A	\$4,600,000	\$260,000	\$4,900,000
4A	\$47,000,000	\$0	\$47,000,000

Notes:

- (1) Present worth estimates assume an annual inflation rate of 2.2 percent. A maximum project life of 30 years is assumed, in accordance with EPA guidance. Estimates are in 1996 dollars.

State Acceptance. The State of Washington has reviewed the Landfill and Clam Bay alternatives, and has expressed a strong preference for Alternative 3A which involves excavation of the landfill toe from the intertidal zone. The state has also indicated that armoring of the landfill toe under Alternative 2A would require mitigation measures to offset the loss of aquatic habitat.

Public Acceptance. The public has had the opportunity to review and comment on the range of alternatives considered for remediation of the Landfill and Clam Bay. At the employee briefing on the preferred alternative, several concerns were raised regarding implementation of the remedial action, including issues of site access, employee health and safety, and disruption of laboratory functions. As noted in the Responsiveness Summary (Attachment A), the on-site laboratories will have opportunities to review and comment on draft versions of the remedial design and construction documents, to assure that employee concerns are addressed before construction activities begin.

The overall supportive public comments received during the comment period for the Proposed Plan and at the public meeting have been interpreted as acceptance of the proposed alternative.

10.2 Evaluation of Fire Training Area Alternatives by Criteria

Overall Protection of Human Health and the Environment. Alternatives 2B and 3B are protective of human health and the environment in terms of reducing the risks associated with dioxin-impacted soil and debris in the Fire Training Area. The primary difference between the alternatives is the extent to which TPH-impacted soils are cleaned up. These soils are excavated and treated on the Site in Alternative 3B. However, since the TPH-impacted soils represent a limited Site risk, this alternative is only slightly more protective than Alternative 2B.

No Action (Alternative 1B) is not protective of human health or the environment, thus will not be considered further in this evaluation.

Compliance with ARARs. Alternatives 2B and 3B comply with all ARARs.

Long-Term Effectiveness and Permanence. Off-site disposal of dioxin-impacted soil and debris in Alternatives 2B and 3B permanently removes from the Site all risks associated with those materials. However, containment is not normally regarded as a permanent technology. Both Alternative 2B and 3B are similar in terms of the reduction of Site risk. By leaving the TPH-impacted soils in-place, Alternative 2B provides some potential for future exposure, although the petroleum residual is largely non-leachable and poses only a minimal risk at the

Site. Landfarming (Alternative 3B) provides permanent reduction of TPH in soil to below the cleanup goal.

Reduction of Toxicity, Mobility, or Volume through Treatment. As noted above, landfarming of TPH-impacted soils in Alternative 3B reduces the toxicity of these soils, whereas Alternative 2B leaves TPH-impacted soils untreated. PCB-impacted petroleum product/sludge removed from the USTs would be disposed of off the Site by placement in an approved landfill or incineration.

Short-Term Effectiveness. The greatest exposure risk to construction workers is in the removal of the debris from inside the simulators, which is a component of Alternatives 2B and 3B. Excavation of dioxin-contaminated surficial soil and external debris presents less of an exposure risk, based on the lower concentrations found in those materials. Exposure risks associated with UST closure/removal and TPH-impacted soil excavation/bioremediation are relatively minor. Construction worker exposure would be minimized through the use of protective clothing, dust control, and respirators if required.

Alternatives 2B and 3B are not expected to have appreciable short-term impacts on the environment or on the local community.

Implementability. The construction components of Alternatives 2B and 3B require only conventional methods and equipment, and are readily implemented. Biological treatment of TPH-impacted soil via landfarming (Alternative 3B) has been demonstrated at many sites, and is readily implemented. The institutional controls associated with the TPH-impacted soils left in-place in Alternative 2B are considered easy to implement.

Cost. The estimated cost of each remediation alternative for the Fire Training Area is shown below:

Alternative	Initial Costs	Present Worth of Annual O&M Costs	Present Worth of Total Costs
1B	\$0	\$0	\$0
2B	\$740,000	\$0	\$740,000
3B	\$2,400,000	\$0	\$2,400,000

Notes:

- (1) Present worth estimates assume an annual inflation rate of 2.2 percent. A maximum project life of 30 years is assumed, in accordance with EPA guidance. Estimates are in 1996 dollars.

State Acceptance. The State of Washington has reviewed the Fire Training Area alternatives and has expressed a preference for Alternative 2B as an appropriate response action. The state has approved this document and the selected remedy.

Public Acceptance. The public has had the opportunity to review and comment on the range of alternatives considered for remediation of the Fire Training Area. The overall supportive public comments received during the comment period for the Proposed Plan and at the public meeting have been interpreted as acceptance of the proposed alternative.

11.0 THE SELECTED REMEDY

The alternative selected for the remedial action at the Manchester Annex Superfund Site is generally consistent with Alternative 3A for the Landfill and Clam Bay sediments, Alternative 2B for the Fire Training Area, and No Action for the Net Depot Area and Manchester State Park. This remedy is preferred because it complies with all ARARs, provides long-term protection of human health and the environment, and is consistent with the state preference, while striking a balance between Site risk reduction and cost. The remedial action, to the extent practicable, will be carried out in a manner that is not likely to jeopardize listed species or adversely affect critical habitat.

The selected remedy, which will cost an estimated \$5.4 million (present worth), includes the following actions.

11.1 Excavation of Intertidal Debris and Placement of Design Fill

- ▶ Landfill debris located in the intertidal zone of Clam Bay will be excavated to the extent necessary to establish a stable shoreline protection system and to allow placement of the design fill (described below). The goal is no net loss of aquatic habitat. A temporary dike or other means will be used to prevent erosion of cut faces into Clam Bay, and construction methods will be selected during remedial design/remedial action to minimize disturbance of the intertidal area adjacent to the excavation. The volume of intertidal debris requiring excavation is estimated to be in the range of 7,000 to 10,000 cubic yards.
- ▶ As described in Larson (1997), it is possible that low-density hunter-fisher-gatherer deposits are on the former beach surface underlying the intertidal debris. A Cultural Resources Management Plan will be prepared during

remedial design which specifies monitoring procedures, personnel qualifications, notification requirements, and treatment of cultural resources if they are discovered during remedial construction.

- ▶ Excavated material will be placed, to the extent possible, on the upland landfill area prior to capping. Based on the presence of submarine nets and the agglomerated nature of the debris, some of the excavated material may be too large or otherwise physically unsuitable for placement/compaction on Site. If determined during remedial design to be cost-effective, techniques such as shearing will be used to reduce the size of excavated debris so that it can be effectively placed on the on-site landfill. Debris that is physically unsuitable for placement on the landfill and not amenable to size reduction will be tested for waste designation purposes and disposed of in an appropriate off-site landfill.
- ▶ The shoreline protection system will be designed to achieve seep cleanup levels (Table 15), provide the best possible habitat for marine organisms, and maximize long-term beach stability. It will include a "design fill" component to help achieve water quality criteria in the seeps by reducing the flux of contaminants leaching from landfill materials (without altogether eliminating tidal exchange), and enhancing tidal dispersion and seawater mixing. Details of the shoreline protection system will be refined during final design.
- ▶ Seeps at the foot of the finished construction, if observed, will be monitored until compliance with seep discharge cleanup levels is established. Additional remedial measures will be implemented, as necessary, if seep discharge cleanup levels are not achieved.

11.2 Placement of Thick Sand Cap over Silt Basin Sediments

- ▶ A cap, consisting of clean sediments or similar material, will be placed in the existing intertidal depression ("silt basin") flush with the surrounding mudline, to isolate contaminated basin sediments from the intertidal environment. Placement of the cap will be coordinated with windrow placement (discussed below).

11.3 Placement of Thin Cap over Remaining Surficial Sediments Exceeding Cleanup Levels

- ▶ A thin cap of clean sediment will be established over intertidal Clam Bay sediment areas which exceed cleanup levels, which are the SQS. The cap area is estimated at roughly 5 acres. Cap material will be placed in windrows, designed to be spread out evenly over time by wind and wave

forces. To the extent practicable, the gradation of the material used will be matched with the existing native sediment grain size.

- ▶ Details of thin capping (including volume of clean sediment applied, windrow design, etc.) will be determined during final design. The overall goal is to reduce contaminant concentrations in surficial sediments sufficiently to assure that sediment dwelling organisms, including harvestable shellfish resources, are adequately protected to support unrestricted use of the cap area within several years of completion of the remedial action.
- ▶ Clam Bay sediment and shellfish tissue will be monitored in intertidal areas currently exceeding the PCB cleanup goal for sediments (40 ug/kg [dry]) until compliance with sediment and shellfish tissue cleanup goals is established, or until the Washington State Department of Health and the Suquamish Tribe determine that the shellfish are safe for subsistence-level harvesting, whichever occurs first.

11.4 Installation of Landfill Cap and Hydraulic Cutoff System

- ▶ Prior to cap construction, any solid waste located west of the utility corridor which runs along the EPA/Manchester State Park property boundary will be excavated and placed on the remaining upland landfill area. (Alternatively, the utility corridor will be relocated to outside the areal extent of solid waste.)
- ▶ After placement of debris excavated from the intertidal area and Manchester State Park (or relocation of the utility corridor), the upland portion of the landfill (approximately 5 to 6 acres) will be capped in accordance with the State of Washington's Minimum Functional Standards (MFS) for solid waste landfill closures. (Design requirements of an MFS cap include a low-permeability cover liner with a 2 percent minimum slope, protective layers above and below the cover liner, landfill gas controls, and close construction quality control and inspection requirements.) The cap will be designed to be consistent with the owner's long-term plans for the property, which may include use of a portion of the landfill area as parking for a future laboratory expansion.
- ▶ A hydraulic cutoff system will be installed upgradient of the landfill area, to capture groundwater and surface water approaching the upgradient edge of the landfill cap, divert captured water around the landfill, and discharge it to Clam Bay. The system will be designed such that it will not serve as a conduit for seawater infiltration into the landfill during high tides.

- ▶ Potential construction-related impacts to existing wetlands in the landfill vicinity will be identified and addressed as part of final design.
- ▶ After completion of upland construction, the area will be revegetated, consistent with long-term O&M requirements and site development plans.
- ▶ A post-closure plan for the landfill cap, hydraulic cutoff system, and shoreline protection system, will be developed during remedial construction and implemented following construction. The post-closure plan will address long-term operation, monitoring, inspection, and maintenance requirements for these systems.

11.5 Excavation/Disposal of Dioxin-Contaminated Debris and Soil

- ▶ Dioxin-contaminated debris (volume estimated at 200 cubic yards) will be removed from the main simulator complex in the Fire Training Area and disposed of in a RCRA hazardous waste landfill.
- ▶ After removal of debris, the floors of the simulators will be inspected for cracks or other routes of potential leakage. If routes of potential leakage are found, soils beneath the simulators will be sampled and analyzed for dioxins. If dioxin concentrations above the cleanup level are detected, the simulator(s) will be demolished, and the underlying contaminated soils excavated.
- ▶ Near-surface soils adjacent to the main simulator complex, and the soil/debris pile north of the main complex, will be sampled and analyzed for dioxins. Soil and debris with concentrations above the cleanup level (estimated at 200 to 300 cubic yards) will be excavated for off-site disposal.
- ▶ Excavated dioxin-contaminated debris and soil, and simulator demolition debris (if applicable), will be tested for waste designation purposes and disposed of in appropriate off-site landfills.

11.6 In-Place Closure of USTs

- ▶ The concrete USTs (five or more) remaining in the Fire Training Area will be closed in-place following state UST closure requirements. Pumpable materials will be removed from the USTs and associated piping, tested for waste designation purposes, and treated/disposed of off Site in an appropriate manner.

- ▶ UST piping systems, and TPH-impacted soil excavated incidentally along with the piping, will be disposed of in an appropriate off-Site landfill. The goal will be to remove all UST system piping. However, pipe sections which are impractical to remove (due to existing utilities or other obstacles), will be purged and abandoned in-place.

11.7 Institutional Controls

In conjunction with the landowners, the Corps will develop and put into place the following institutional controls:

- ▶ A description of the activities or prohibitions required for continued maintenance and protection of the remedial action, including the landfill cap, shoreline protection system, and hydraulic cutoff system, will be prepared during remedial design. These requirements will be subsequently placed in the GSA files, the County Land Use Records, and all applicable public files for the property, including locations at the site, EPA regional office, and EPA headquarters. In addition, deed covenants prohibiting future residential use of the property, and describing the maintenance and protection requirements, will be prepared and submitted for EPA approval. The deed covenants shall be executed upon any future transfer of the property out of federal government ownership.
- ▶ A restriction on subsistence-level harvesting of shellfish until the Washington State Department of Health and the Suquamish Tribe determine that the shellfish are safe for subsistence-level harvesting. The Suquamish Tribe will be responsible for prohibiting subsistence-level harvesting of shellfish.
- ▶ An institutional control plan, including deed covenants as necessary, will be prepared and submitted for NMFS approval to address TPH-impacted soil left in-place in the Fire Training Area. The institutional control plan shall include the following (as appropriate):
 - Execution of a deed covenant prohibiting future residential use of the property, and describing the presence of TPH-impacted soils, including information on location/depth, concentrations, and health and safety concerns;
 - All contractors and employees working in future subsurface excavations within and adjacent to the UST areas of the Site will be notified of the requirement to utilize health and safety precautions normally applicable to UST removals;

- Temporary storm water controls and other best management practices (BMPs) such as temporary soil covers and subsurface liners will be used during future soil excavation activities in these areas to minimize infiltration and runoff of soil materials;
- Subsurface soil excavations within these areas will be observed by a qualified environmental professional to determine if such soils contain free product. If free product is encountered, off-Site landfill disposal of these materials will be the prospective remedy. If free product is not encountered, the soils will be allowed to be returned to the original excavation, or very close to the original excavation in a substantially similar environment; and
- Future storm water runoff systems at the Site will be designed to divert runoff away from the former UST areas.

NMFS will be responsible for ensuring long-term compliance with the institutional control plan for the NOAA property. Compliance with this plan will obviate the need for further sampling or remedial actions associated with TPH-impacted soil left in-place in the Fire Training Area.

Each property owner will ensure that future construction will not compromise the institutional controls that are put into place. The effectiveness of the institutional controls will be evaluated as part of reviews to be conducted at 5-year intervals, at a minimum, or as required based on the performance evaluation criteria of this remedy.

The Manchester Annex Work Group will continue to function during planning and implementation of the selected remedy. Interested parties, such as Site employees, will be encouraged to be involved in design and construction issues through the Work Group.

12.0 STATUTORY DETERMINATIONS

The remedial action for implementation at the Manchester Annex Superfund Site is consistent with CERCLA and, to the extent practicable, the NCP. The selected remedy is protective of human health and the environment, attains all ARARs, and is cost-effective.

12.1 Protection of Human Health and the Environment

The selected remedial action is protective of human health and the environment through a combination of on-Site containment/capping, beach stabilization, off-Site disposal, and institutional controls. Excavating the intertidal landfill debris, constructing a stable beach, capping the upland landfill, and installing a hydraulic cutoff system upgradient of the landfill will isolate landfill wastes from human contact and the environment, and reduce or eliminate future contaminant discharges to Clam Bay. Capping of the "silt basin" and placement of a thin cap over remaining impacted sediments, enhancing the natural recovery process, will reduce surface sediment and shellfish tissue chemical concentrations to levels protective of human health and the environment. Temporary restrictions on subsistence-level harvesting of shellfish will ensure protection of public health until the Washington State Department of Health and the Suquamish Tribe determine that the shellfish are safe for subsistence-level harvesting.

Excavation and off-site disposal of dioxin-impacted debris and soil will address the primary risk concerns in the Fire Training Area. Institutional controls addressing TPH-impacted soil left in-place at the Site will provide protection of human health and the environment from these materials.

12.2 Compliance with Applicable or Relevant and Appropriate Requirements

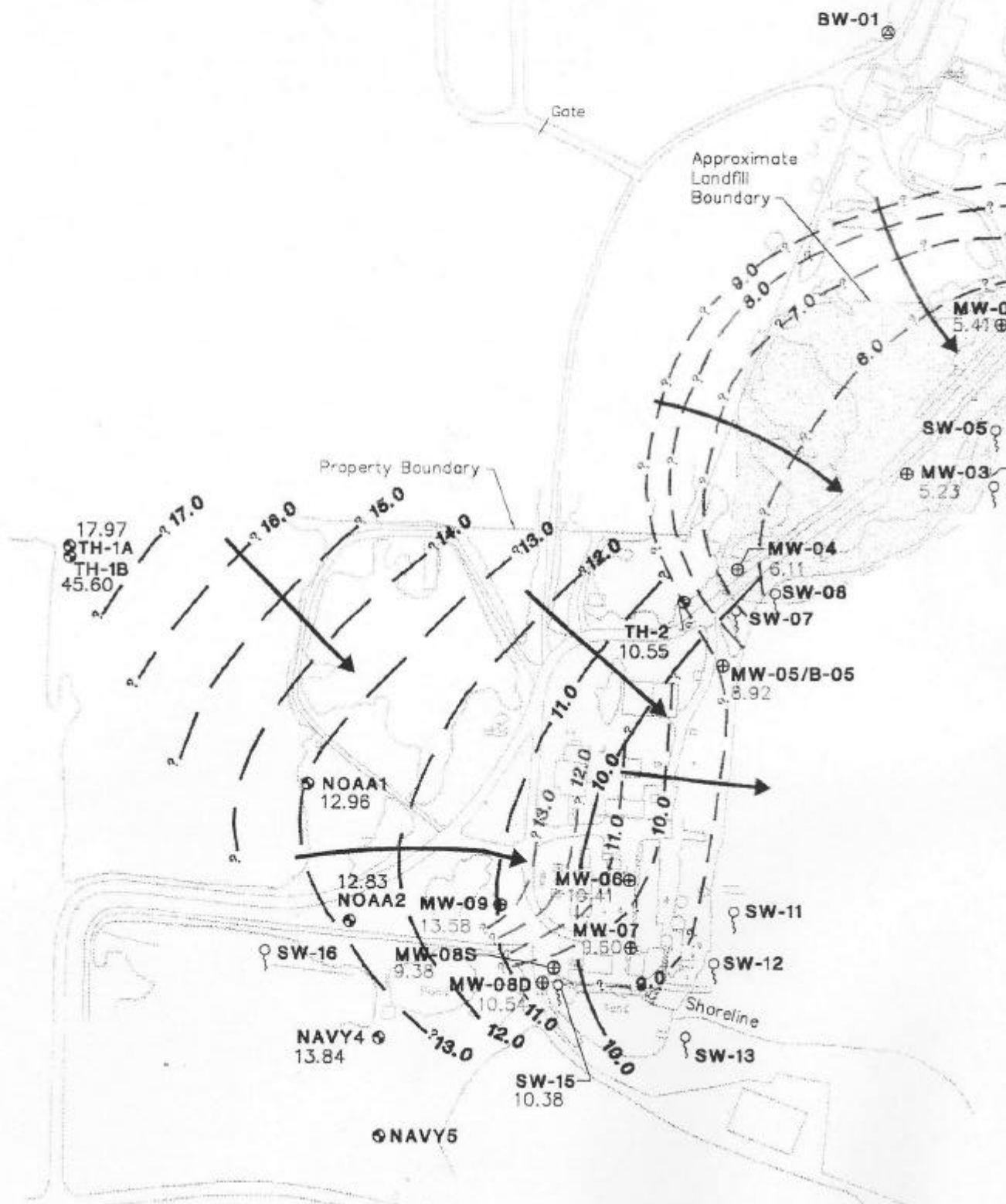
The selected remedy will comply with all chemical-, action-, and location-specific applicable or relevant and appropriate requirements (ARARs). The AKARs are presented below.

Landfill Area, Clam Bay, and Fire Training Area ARARs

- ▶ **The State of Washington Hazardous Waste Management Act** (Chapter 70.105 RCW) establishes requirements for dangerous waste and extremely hazardous waste, as codified in Chapter 173-303 WAC. This regulation is applicable to wastes that are taken outside an existing area of contamination. The regulation designates those solid wastes which are dangerous or extremely hazardous to the public health and the environment; provides surveillance and monitoring requirements for such wastes until they are detoxified, reclaimed, neutralized, or disposed of safely; and establishes monitoring requirements for dangerous and extremely hazardous waste transfer, treatment, storage, and disposal facilities.
- ▶ **The State of Washington Hazardous Waste Cleanup - Model Toxics Control Act** (MTCA; Chapter 70.105D RCW) establishes requirements for the identification, investigation, and cleanup of facilities where hazardous

Groundwater Elevation Contour Map

Wet Season - March 1995





⊕ MW-07 RI/FS Monitoring Well Location and Number

⊕ NOAA1 Existing Monitoring Well Location and Number

○ SW-08 RI/FS Surface Water/Seep Sample Location and Number

⊕ BW-01 RI/FS Surface Water Location and Number

Groundwater Elevation Contour in Feet

8.0 — — — — — Surficial Fill/Landfill Zone

10.0 — — — — — Outwash Channel/Deep Proglacial Deposits

10.38 — — — — — Groundwater Elevation in Feet

← Generalized Groundwater Flow Direction

N

0 250 500
Scale in Feet



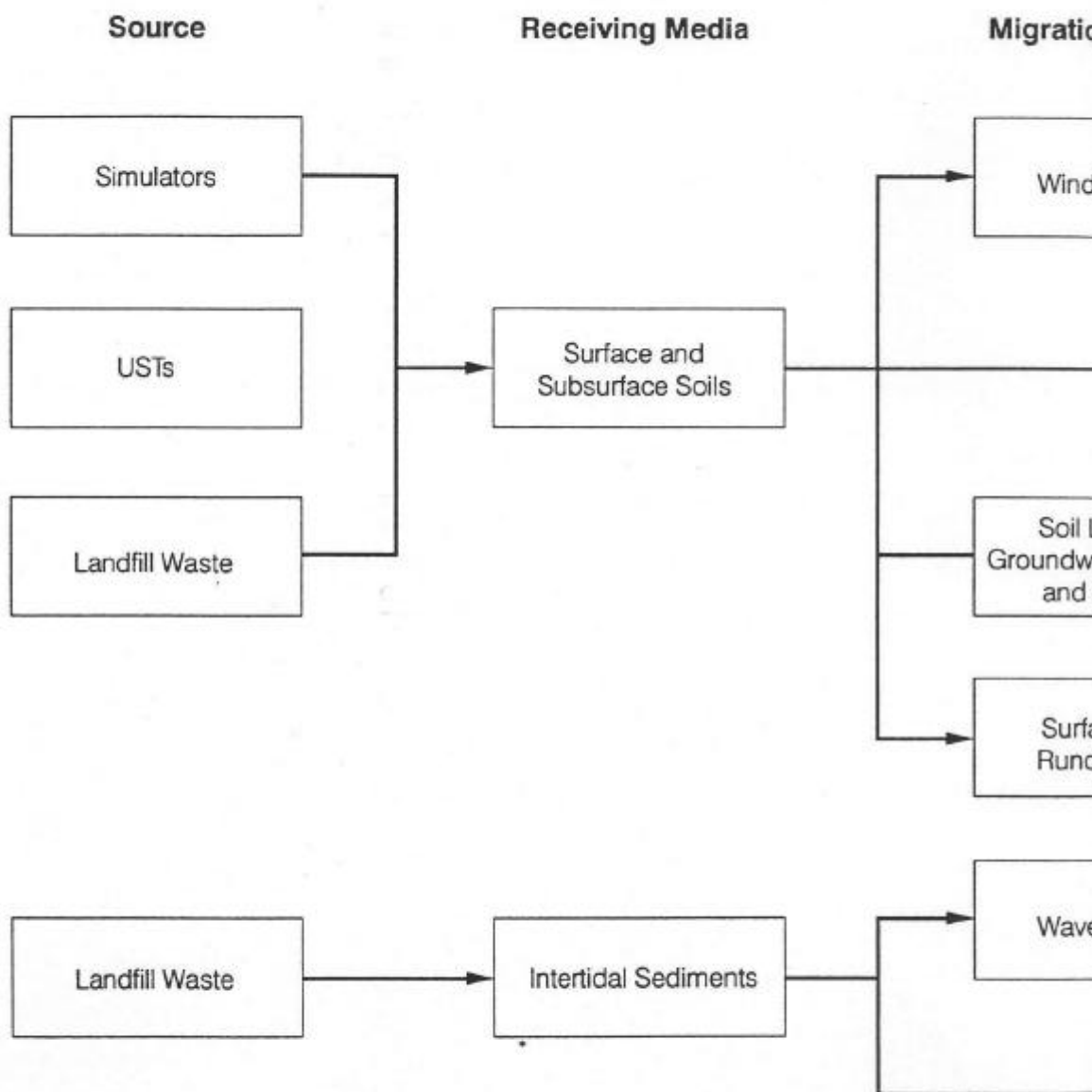
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Figure 4

Conceptual Model - Human Health Risk Assessment

Manchester Annex Site



substances have come to be located, as codified in Chapter 173-340 WAC. Soil, groundwater, and surface water cleanup standards established under the MTCA, along with overall cancer risk and hazard index requirements, are applicable for determining remediation areas and volumes and compliance monitoring requirements within the Landfill Area, Clam Bay, and Fire Training Area of the Site.

- ▶ **The State of Washington Sediment Management Standards (SMS;** Chapter 173-204 WAC) establish chemical-specific sediment quality standards (SQS) which are applicable within Clam Bay to control potential adverse effects on biological resources. Sediments must meet the cleanup standards within ten years after completion of the remedial action.
- ▶ **The State of Washington Surface Water Quality Standards (SWQS;** Chapter 173-201A WAC), as developed pursuant to the federal ambient water quality criteria (40 CFR 131) are applicable chemical-specific standards for determining cleanup requirements for surface water discharges, including tidal seeps from the landfill area.
- ▶ **The Toxic Substances Control Act (TSCA)** establishes storage and disposal requirements for wastes containing PCBs greater than 50 ppm (40 CFR 761). These requirements are applicable to wastes that are taken outside of an existing area of contamination.
- ▶ **The State of Washington Clean Air Act** (Chapter 70.94 RCW), including Implementation of Regulations for Air Contaminant Sources (Chapter 173-403 WAC), and Controls for New Sources of Toxic Air Pollutants (Chapter 173-460 WAC) are applicable standards for determining ambient concentrations of toxic air contaminants allowed during remedial actions conducted throughout the Site. In addition, requirements for control of fugitive dusts and other air emissions during excavation and cleanup-related activities, as codified in WAC 173-400-040, are also applicable to remedial actions.
- ▶ **Sections 401 and 404(b)(1) of the Federal Clean Water Act (40 CFR 230) and Section 10 of the Rivers and Harbors Act (33 CFR 320-330)** protect marine environments and prevent unacceptable adverse effects on shellfish beds, fisheries, wildlife, and recreational areas during dredging activities. These regulations are applicable to excavation, dredging, and fill activities conducted in the intertidal area of Clam Bay and in possible wetlands within the upland landfill area.

- ▶ **The State of Washington Underground Storage Tank Regulations** (Chapter 173-360 WAC) establish requirements for the permanent closure of USTs (173-360-385 WAC) which are applicable to in-place closure of the concrete USTs in the Fire Training Area.
- ▶ **The Kitsap County Shoreline Master Plan** (WAC 173-19-2604), as developed pursuant to the State of Washington Shoreline Management Act (Chapter 90.58 RCW) covers fill, dredging, and other remedial activities conducted in Clam Bay within 200 feet of the shoreline.
- ▶ **State of Washington (WISHA) and Federal (OSHA)** requirements are applicable standards establishing safe operating procedures and requirements for the conduct of all remedial actions at the Site. The state regulations are codified in Chapter 296-62 (Part P) WAC.
- ▶ **The CERCLA Off-Site Disposal Rule**, as set forth in an amendment to the NCP, Procedures for Planning and Implementing Offsite Response Actions (40 CFR 300.440), is applicable to off-site disposal actions included in the selected remedy. In addition, RCRA establishes land disposal restrictions (40 CFR Part 268) that must be met before hazardous wastes can be land disposed.
- ▶ **The State of Washington Minimal Functional Standards (MFS) for Solid Waste Handling** (Chapter 173-304 WAC) are relevant and appropriate standards for the design of landfill containment and long-term operations and maintenance requirements within the landfill cap area.
- ▶ **The State of Washington Hydraulic Code Rules** (Chapter 220-110 WAC) contains standards for removal and filling actions waterward of the ordinary high water elevation.
- ▶ **The Endangered Species Act** (16USC 1531-1544) conserves threatened or endangered species.

Other Criteria, Advisories, or Guidance To-Be-Considered (TBC)

- ▶ Executive Orders 11990 and 11988 (40 CFR 6, Appendix A), which are intended to avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial uses of wetlands and floodplains.
- ▶ Requirements and guidelines for evaluating dredged material, disposal site management, disposal site monitoring, and data management established by Puget Sound Dredge Disposal Analysis (PSDDA, 1988 and 1989).

- ▶ Critical toxicity values (acceptable daily intake levels, carcinogenic potency factor) and U.S. Food and Drug Administration action levels for concentrations of mercury and PCBs in edible seafood tissue.
- ▶ EPA Wetlands Action Plan (EPA, 1989) describing the National Wetland Policy and primary goal of "no net loss."
- ▶ Puget Sound Storm Water Management Program (pursuant to 40 CFR Parts 122-24, and RCW 90.48).
- ▶ Puget Sound Estuary Program Protocols, (1987) as amended, for sample collection, laboratory analysis, and QA/QC procedures.

12.3 Cost Effectiveness

The selected remedy is cost-effective because it is protective of human health and the environment, achieves ARARs, and its effectiveness in meeting the objectives of the selected remedy is proportional to its cost. Cost-effectiveness was also established in the presumptive remedy for military landfills. Specific risk and cost balances achieved by the selected remedy include the following:

- ▶ On-site containment of landfill wastes is more cost-effective and affords the same relative risk reduction as treatment and disposal of wastes in an off-site landfill.
- ▶ Implementing effective source controls, including capping of Clam Bay sediments, provides long-term protection at significantly lower cost than sediment dredging and off-site disposal.
- ▶ Removing dioxin-impacted soil, which represents the majority of Site risk in the Fire Training Area, and implementing institutional controls to address low risk TPH-impacted soils left in-place, achieve an effective balance of risk reduction and cost.

The selected remedial components are substantially more cost-effective than the alternative components considered, while achieving the same substantive risk reduction.

12.4 Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

The Corps and EPA have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a cost-effective manner for the Manchester Annex Superfund Site.

12.5 Preference for Treatment as Principal Element

The selected remedy uses no treatment technologies except possible incineration of PCB-containing UST residue associated with the Fire Training Area. Given the large volume and nature of the waste at the Site, containment, as a presumptive remedy for the landfill, provides effective protection of human health and the environment at a considerably lower cost than treatment to achieve the same degree of risk reduction.

13.0 DOCUMENTATION OF NO SIGNIFICANT CHANGES

The Corps and EPA released the Manchester Annex Superfund Site Proposed Plan (preferred remedial alternative) for public comment on April 1, 1997. The preferred alternative presented in the proposed plan is the same as the selected alternative presented in this Record of Decision. The Corps and EPA reviewed all written and verbal comments submitted during the public comment period. Upon review of those comments, it was determined that no significant changes to the remedy, as it was originally identified in the proposed plan, were necessary.

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^(A) This is a partial list of documents used in preparing the Record of Decision. The decision is based on the administrative record for the Site.

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Table 1 - Listing of Chemicals of Potential Concern, Manchester Annex Site

Metals

Antimony
Arsenic
Beryllium
Cadmium
Chromium
Copper
Lead
Manganese
Mercury
Nickel
Selenium
Silver
Thallium
Vanadium
Zinc

Miscellaneous Inorganics

Asbestos
Cyanide

Volatile Organic Compounds

Vinyl chloride
Benzene

Polynuclear Aromatic Hydrocarbons (PAHs)

Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Dibenzo(a,h)anthracene
Fluoranthene
Indeno(1,2,3-cd)pyrene

Semivolatile Organics

2,4-Dimethylphenol
Di-n-Butylphthalate

PCBs and Pesticides

Total PCBs
Aldrin
4,4'-DDT
4,4'-DDE
4,4'-DDD

Dioxins and Furans

2,3,7,8-TCDD
1,2,3,7,8-PeCDD
1,2,3,4,7,8-HxCDD
1,2,3,6,7,8-HxCDD
1,2,3,7,8,9-HxCDD
1,2,3,4,6,7,8-HpCDD
OCDD
2,3,7,8-TCDF
1,2,3,7,8-PeCDF
2,3,4,7,8-PeCDF
1,2,3,4,7,8-HxCDF
1,2,3,6,7,8-HxCDF
1,2,3,7,8,9-HxCDF
2,3,4,6,7,8-HxCDF
1,2,3,4,6,7,8-HpCDF
1,2,3,4,7,8,9-HpCDF
OCDF

Total Petroleum Hydrocarbons

As Gasoline
As Diesel
As Oil

419119/ROD-Revised.xls - Table 1

Table 2 - Summary of Soil Quality Data for Landfill Area

	Detection Frequency	Maximum Detection	Human Health Screening Level	Human Health Exceedence Frequency (1)	Plant and Wildlife Screening Level	Plant and Wildlife Exceedence Frequency (1)
Inorganics in mg/kg						
Cyanide	0/5	ND	1600	0/5		
Total Metals in mg/kg						
Antimony	15/25	415 J	31	9/25	5	14/25
Arsenic	31/31	523	7.3	19/31	10	16/31
Beryllium	24/31	2.9	0.61	5/31	10	0/30
Cadmium	25/31	22800	2	21/31	2	21/31
Chromium	31/31	690 N	100	12/31	48	16/31
Copper	31/31	23400	2900	5/31	50	23/31
Lead	30/31	56000	250	16/31	50	21/31
Manganese	20/20	1500 J	1100	1/20		
Mercury	20/31	3.7	7	0/31	0.1	12/29
Nickel	31/31	926 N	1600	0/31	48	17/31
Selenium	3/31	0.85 NE	390	0/31	1	0/14
Silver	19/31	67620	240	1/31	2	15/26
Thallium	0/25	ND	5.6	0/24	1	0/15
Vanadium	20/20	590	550	1/20		
Zinc	31/31	23800	23000	1/31	85	25/31
Volatiles in µg/kg						
Benzene	5/6	8	500	0/6	40000	0/6
Vinyl Chloride	2/6	280	2	2/6	570	0/6
Semivolatiles in µg/kg						
2,4-Dimethylphenol	0/15	ND	1600000	0/15		
Benzo(a)Anthracene	4/15	2800	880	1/14		
Benzo(a)Pyrene	4/15	2600 J	88	2/5	1500	1/14
Benzo(b)Fluoranthene	4/15	5300 JX	880	1/14		
Dibenzo(a,h)Anthracene	2/15	930 J	88	2/5		
Di-N-Butylphthalate	4/15	150	100000	0/15	71	1/6
Fluoranthene	7/15	8600	68000	0/15		
Indeno(1,2,3-c,d)Pyrene	3/15	2100 J	880	1/14		
Total cPAHs	6/15	21430	1000	4/7		

Table 2 - Summary of Soil Quality Data for Landfill Area

	Detection		Human Health		Plant and Wildlife	
	Frequency	Maximum Detection	Screening Level	Exceedence Frequency (1)	Screening Level	Exceedence Frequency (1)
Pesticide/PCBs in µg/kg						
4,4'DDD	3/5	10 J	2700	0/5	0.5	2/3
4,4'DDE	2/5	160 J	1900	0/5	0.5	2/2
4,4'DDT	2/5	5.9 J	1000	0/5	0.5	2/2
Aldrin	0/5	ND	38	0/5	670	0/5
Total PCBs	19/27	8900	83	18/22	180	12/26
Dioxins in ng/kg						
2378-TCDD	3/4	110 J	4	3/4		
12378-PeCDD	3/4	24	8	3/4		
123478-HxCDD	3/4	32	40	3/4		
123578-HxCDD	4/4	553	40	3/4		
123789-HxCDD	4/4	922	40	3/4		
1234678-HpCDD	4/4	2140	400	3/4		
OCDD	4/4	4900	4000	2/4		
2378-TCDF	4/4	1440 NC	40	3/4		
12378-PeCDF	4/4	1410	80	3/4		
23478-PeCDF	4/4	1640	80	3/4		
123478-HxCDF	4/4	3270	40	3/4		
123578-HxCDF	4/4	939	40	3/4		
123789-HxCDF	3/4	83.6 J	40	1/4		
234578-HxCDF	4/4	1190	40	3/4		
1234678-HpCDF	4/4	4360	400	3/4		
1234789-HpCDF	3/4	228	400	0/4		
OCDF	3/4	922	4000	0/4		
2378-TCDD Equivalents	4/4	2100				
Total Petroleum Hydrocarbons in mg/kg						
Diesel	5/11	280	200	1/11		
Oil	7/11	2300	200	5/11		

(1) Undetected sample results with quantitation limits greater than screening levels were excluded from exceedence frequency calculation

419119/ROD-Revised.xls - Table 2

Table 3 - Summary of Soil Quality Data for Fire Training Area

	Detection		Human Health		Plant and Wildlife	
	Frequency	Maximum Detection	Screening Level	Exceedence Frequency (1)	Screening Level	Exceedence Frequency (1)
Inorganics in mg/kg						
Cyanide	0/9	ND	1600	0/9		
Total Metals in mg/kg						
Antimony	0/9	ND	31	0/9	5	0/9
Arsenic	9/9	12.6	7.3	1/9	10	1/9
Berillium	1/9	0.55	0.61	0/9	10	0/9
Cadmium	4/9	1.2	2	0/9	2	0/9
Chromium	9/9	21.5	100	0/9	48	0/9
Copper	9/9	69.5	2900	0/9	50	2/9
Lead	5/8	113	250	0/8	50	1/8
Mercury	6/9	0.14	7	0/9	0.1	1/9
Nickel	9/9	29	1600	0/9	48	0/9
Selenium	0/9	ND	390	0/9	1	0/0
Silver	0/9	ND	240	0/9	2	0/9
Thallium	4/9	0.27	5.6	0/9	1	0/9
Zinc	9/9	253	23000	0/9	85	1/9
Volatiles in µg/kg						
Benzene	3/14	72	500	0/14	40000	0/14
Vinyl Chloride	0/10	ND	2	0/6	570	0/10
Semivolatiles in µg/kg						
2,4Dimethylphenol	0/9	ND	1600000	0/9		
Benzo(a)Anthracene	2/9	210	880	0/9		
Benzo(a)Pyrene	2/9	240	88	1/9	1500	0/9
Benzo(b)Fluoranthene	3/9	690 X	880	0/9		
Dibenzo(a,h)Anthracene	0/9	ND	88	0/9		
Di-N-Butylphthalate	0/9	ND	100000	0/9	71	0/5
Fluoranthene	2/9	350	68000	0/9		
Indeno(1,2,3-c,d)Pyrene	1/9	400	880	0/9		
Total cPAHs	4/9	2529	1000	1/9		

Table 3 - Summary of Soil Quality Data for Fire Training Area

	Detection Frequency	Maximum Detection	Screening Level	Exceedence Frequency (1)	Screening Level	Exceedence Frequency (1)
Pesticide/PCBs in µg/kg						
4,4'-DDE	0/9	ND	2700	0/9	0.5	0/0
4,4'-DDE	0/9	ND	1900	0/9	0.5	0/0
4,4'-DDT	0/9	ND	1000	0/9	0.5	0/0
Aldrin	0/9	ND	38	0/9	670	0/9
Total PCBs	2/9	580	83	1/6	180	1/9
Dioxins in ng/kg						
2378-TCDD	2/30	274	4	2/5		
12373-PeCDD	6/30	2590	8	6/18		
123478-HxCDD	7/30	4070	40	5/23		
123678-HxCDD	9/30	28100	40	8/24		
123789-HxCDD	9/30	23000 I	40	7/23		
1234578-HpCDD	29/30	1260000 D	400	15/30		
OCDD	30/30	5820000 JD	4000	14/30		
2378-TCDF	8/30	840	40	5/22		
12378-PeCDF	2/30	266	80	2/21		
23478-PeCDF	6/30	505	80	4/22		
123478-HxCDF	15/30	5060 E	40	9/23		
123678-HxCDF	5/30	444	40	3/21		
123789-HxCDF	1/30	240	40	1/20		
234678-HxCDF	14/30	808	40	4/22		
1234578-HpCDF	22/30	20600	400	5/30		
1234789-HpCDF	8/30	1510	400	2/30		
OCDF	21/30	31900	4000	3/30		
2378-TCDD Equivalents	30/30	26000				
Total Petroleum Hydrocarbons in mg/kg						
Diesel	23/77	15000	200	13/77		
Gasoline	2/9	480	100	1/9		
Oil	20/77	7700	200	18/77		

(1) Undetected sample results with quantitation limits greater than screening levels were excluded from exceedence frequency calculations.

Table 4 - Summary of Soil Quality Data for Net Depot Area

	Detection		Human Health		Plant and Wildlife	
	Frequency	Maximum Detection	Screening Level	Exceedence Frequency (1)	Screening Level	Exceedence Frequency (1)
Inorganics in mg/kg						
Cyanide	2/3	1	1600	0/3		
Total Metals in mg/kg						
Antimony	0/3	ND	31	0/3	5	0/2
Arsenic	6/6	8.4	7.3	1/6	10	0/6
Beryllium	6/6	0.65	0.61	1/6	10	0/6
Cadmium	5/6	4.7	2	3/6	2	3/6
Chromium	6/6	37	100	0/6	48	0/6
Copper	6/6	71	2900	0/6	50	1/6
Lead	6/6	72	250	0/6	50	2/6
Manganese	3/3	283 J	1100	0/3		
Mercury	5/6	0.31	7	0/6	01	1/6
Nickel	6/6	19.5	1600	0/6	48	0/6
Selenium	0/6	ND	390	0/6	1	0/3
Silver	0/6	ND	240	0/6	2	0/6
Thallium	0/6	ND	5.6	0/6	1	0/3
Vanadium	3/3	71	550	0/3		
Zinc	6/6	409	23000	0/6	85	5/6
Volatiles in µg/kg						
Benzene	0/3	ND	500	0/3	40000	0/3
Vinyl Chloride	0/3	ND	2	0/3	570	0/3
Semivolatiles in µg/kg						
2,4-Dimethylphenol	0/6	ND	1600000	0/6		
Benzo(a)Anthracene	2/6	170	880	0/6		
Benzo(a)Pyrene	2/6	140	88	1/3	1500	0/6
Benzo(b)Fluoranthene	2/6	410 X	880	0/6		
Dibenzo(a,h)Anthracene	0/6	ND	88	0/3		
Di-N-Butylphthalate	1/6	11 J	100000	0/6	71	0/3
Fluoranthene	2/6	270	68000	0/6		
Indeno(1,2,3-c,d)Pyrene	2/6	100	880	0/6		
Total cPAHs	2/6	1437	1000	1/3		

Table 4 - Summary of Soil Quality Data for Net Depot Area

	Detection		Human Health		Plant and Wildlife	
	Frequency	Maximum Detection	Screening Level	Exceedence Frequency (1)	Screening Level	Exceedence Frequency (1)
Pesticide/PCBs in µg/kg						
4,4'DDD	0/3	ND	2700	0/3	0.5	0/0
4,4'DDE	0/3	ND	1900	0/3	0.5	0/0
4,4'DDT	0/3	ND	1000	0/3	0.5	0/0
Aldrin	0/3	ND	38	0/3	670	0/3
Total PCBs	2/3	131	83	1/2	180	0/3
Dioxins in ng/kg						
2378-TCDD	1/1	0.67 J	4	0/1		
12378-PeCDD	1/1	2.1 J	8	0/1		
123478-HxCDD	1/1	2.05 J	40	0/1		
123678-HxCDD	1/1	11.4 J	40	0/1		
123789-HxCDD	1/1	6.6 J	40	0/1		
1234678-HpCDD	1/1	136	400	0/1		
OCDD	1/1	1620	4000	0/1		
2378-TCDF	1/1	8.69 NC	40	0/1		
12378-PeCDF	0/1	ND	80	0/1		
23478-PeCDF	1/1	4.31 J	80	0/1		
123478-HxCDF	0/1	ND	40	0/1		
123678-HxCDF	1/1	2.79 J	40	0/1		
123789-HxCDF	0/1	ND	40	0/1		
234678-HxCDF	1/1	5.3 J	40	0/1		
1234678-HpCDF	1/1	53 J	400	0/1		
1234789-HpCDF	1/1	2.38 J	400	0/1		
OCDF	1/1	173	4000	0/1		
2378-TCDD Equivalents	1/1	11.26				
Total Petroleum Hydrocarbons in mg/kg						
Diesel	2/3	47	200	0/3		
Oil	2/3	350	200	2/3		

(1) Undetected sample results with quantitation limits greater than screening levels were excluded from exceedence frequency calculations.

Table 5 - Summary of Groundwater Quality Data for Landfill Area (Surficial Fill Unit)

	Detection Frequency	Maximum Detection	Seep Discharge Screening Level (2)	Exceedence Frequency (1)
Total Metals in µg/L				
Antimony	9/9	125		
Arsenic	6/9	109	36	2/9
Beryllium	1/6	4.2		
Cadmium	5/9	111		
Chromium	7/9	419	50	2/9
Copper	8/9	3130		
Lead	7/9	2280		
Manganese	3/3	2710		
Mercury	3/9	1.6	0.025	3/3
Nickel	9/9	716		
Selenium	0/3	ND	71	0/3
Silver	7/9	28.6 *	1.2	4/9
Thallium	2/6	1.9		
Zinc	9/9	24100		
Dissolved Metals in µg/L				
Antimony	13/13	33.3		
Arsenic	4/13	14.8 J	36	0/13
Beryllium	0/10	ND		
Cadmium	3/13	13.1	8	1/13
Chromium	6/13	5.6	50	0/13
Copper	10/13	179	10.6	4/13
Lead	6/13	7.2	5.8	1/13
Manganese	3/3	2010		
Mercury	0/13	ND	0.025	0/0
Nickel	9/13	252 J	7.9	6/13
Selenium	0/3	ND	71	0/3
Silver	4/13	1.6	1.2	1/13
Thallium	1/10	1		
Zinc	11/13	5740	77	6/13
Volatiles in µg/L				
Benzene	3/3	22	700	0/3
Vinyl Chloride	0/3	ND		
Pesticide/PCBs in µg/L				
PCB-1254	0/3	ND	0.03	0/0
PCB-1260	0/3	ND	0.03	0/0
Total PCBs	0/3	ND	0.03	0/0
Total Petroleum Hydrocarbons in mg/L				
Diesel	8/12	1.1	1	1/12
Gasoline	3/3	1.3	1	1/3
Oil	0/12	ND	1	0/12

(1) Undetected sample results with quantitation limits greater than screening levels were excluded from exceedence frequency calculations.

(2) Seep discharge screening level based on protection of marine aquatic life.

419119/ROD-Revised.xls - Table 5

Table 6 - Summary of Groundwater Quality Data for Outwash Channel Aquifer

	Detection Frequency	Maximum Detection	Drinking Water Screening Level	Exceedence Frequency (1)	Seep Discharge Screening Level (2)	Exceedence Frequency (1)
Inorganics in µg/L						
Cyanide	0/5	ND	200	0/5	1	0/5
Total Metals in µg/L						
Antimony	1/5	1.2	6	0/5		
Arsenic	4/5	14.5	5	4/5	36	0/5
Beryllium	0/5	ND	0.016	0/0		
Cadmium	0/5	ND	5	0/5		
Chromium	4/5	40.2	80	0/5	50	0/5
Copper	5/5	39	590	0/5		
Lead	4/5	8.1	5	1/5		
Mercury	0/5	ND	2	0/5	0.025	0/0
Nickel	4/5	37.8	100	0/5		
Selenium	1/5	91.1 J	50	1/5	71	1/5
Silver	2/5	0.51	80	0/5		
Thallium	0/5	ND	1.1	0/5		
Zinc	2/5	83.7	4800	0/5		
Dissolved Metals in µg/l						
Antimony	0/5	ND	6	0/5		
Arsenic	4/5	14.5	5	4/5		
Beryllium	0/5	ND	0.016	0/0		
Cadmium	0/5	ND	5	0/5	8	0/5
Chromium	2/5	12.9	80	0/5		
Copper	5/5	13.6	590	0/5	10.6	1/5
Lead	3/5	1.2	5	0/5	5.8	0/5
Mercury	0/5	ND	2	0/5		
Nickel	4/5	21.2	100	0/5	7.9	2/5
Selenium	1/5	55.9 J	50	1/5		
Silver	0/5	ND	80	0/5	1.2	0/5
Thallium	0/5	ND	1.1	0/5		
Zinc	0/5	ND	4800	0/5	77	0/5

Table 6 - Summary of Groundwater Quality Data for Outwash Channel Aquifer

	Detection Frequency	Maximum Detection	Drinking Water		Seep Discharge	
			Screening Level	Exceedence Frequency (1)	Screening Level (2)	Exceedence Frequency (1)
Volatiles in µg/L						
Benzene	0/10	ND	0.36	0/0	700	0/10
Vinyl Chloride	0/10	ND	0.019	0/0		
Semivolatiles in µg/L						
2,4-Dimethylphenol	0/5	ND	320	0/5		
Benzo(a)Anthracene	0/9	ND	0.092	0/4	300	0/9
Benzo(a)Pyrene	0/9	ND	0.0092	0/0	300	0/9
Benzo(b)Fluoranthene	0/9	ND	0.092	0/4	300	0/9
Dibenzo(a,h)Anthracene	0/9	ND	0.0092	0/0	300	0/9
Di-N-Butylphthalate	0/5	ND	1600	0/5		
Fluoranthene	0/9	ND	640	0/9	300	0/9
Indeno(1,2,3-c,d)Pyrene	1/9	0.01 J	0.092	0/4	300	0/9
Total CPAHs	1/9	0.1265	0.1	1/1		
Pesticide/PCBs in µg/L						
4,4'-DDD	0/5	ND	0.28	0/5	0.001	0/0
4,4'-DDE	0/5	ND	0.2	0/5	0.001	0/0
4,4'-DDT	0/5	ND	0.2	0/5	0.001	0/0
Aldrin	0/5	ND	0.004	0/5	0.0019	0/0
PCB1254	0/5	ND	0.0087	0/0	0.03	0/0
PCB1260	0/5	ND	0.0087	0/0	0.03	0/0
Total PCBs	0/5	ND	0.0087	0/0	0.03	0/0
Dioxins in ng/L						
2378-TCDD	0/9	ND	0.0004	0/0	9E-06	0/0
12378-PeCDD	0/9	ND	0.0008	0/0	1.7E-05	0/0
123478-HxCDD	0/9	ND	0.004	0/3	8.6E-05	0/0
123678-HxCDD	0/9	ND	0.004	0/3	8.6E-05	0/0
123789-HxCDD	0/9	ND	0.004	0/3	8.6E-05	0/0
1234678-HpCDD	5/9	0.029 J	0.04	0/5	0.00086	5/5
OCDD	6/9	151	0.4	1/6	0.00864	6/6
2373-TCDF	0/9	ND	0.004	0/5	8.6E-05	0/0
12378-PeCDF	0/9	ND	0.008	0/5	0.00017	0/0

Table 6 - Summary of Groundwater Quality Data for Outwash Channel Aquifer

	Detection Frequency	Maximum Detection	Drinking Water		Seep Discharge	
			Screening Level	Exceedence Frequency (1)	Screening Level (2)	Exceedence Frequency (1)
23478-PeCDF	0/9	ND	0.008	0/9	1.7E-05	0/0
Dioxins in ng/L						
123478-HxCDF	1/9	0.004 J	0.004	0/4	8.6E-05	1/1
123578-HxCDF	1/9	0.003 J	0.004	0/5	8.6E-05	1/1
123789-HxCDF	0/9	ND	0.004	0/3	8.6E-05	0/0
234578-HxCDF	3/9	3.6	0.004	2/6	8.6E-05	3/3
1234678-HpCDF	1/9	0.006 J	0.04	0/5	0.00086	1/1
1234789-HpCDF	0/9	ND	0.04	0/5	0.00086	0/0
OCDF	2/9	0.012 J	0.4	0/5	0.00864	1/5
2378-TCDD Equivalents	6/6	0.36				
Total Petroleum Hydrocarbons in mg/L						
Diesel	5/15	0.59	1	0/15	1	0/15
Oil	0/5	ND	1	0/15	1	0/15

(1) Undetected sample results with quantitation limits greater than screening levels were excluded from exceedence frequency calculations.

(2) Seep discharge screening level based on protection of marine aquatic life.

419119/ROD-Revised.xls - Table 6

Table 7 - Summary of Seep Quality Data for Landfill Area

Sheet 1 of 2

	Detection Frequency	Maximum Detection	Seep Discharge Screening Level (2)	Exceedence Frequency (1)
Inorganics in µg/L				
Cyanide	1/2	5	1	1/1
Total Metals in µg/L				
Antimony	12/16	20.3		
Arsenic	0/16	N/A	36	0/16
Beryllium	0/12	N/A		
Cadmium	8/16	4.4 J		
Chromium	11/16	7.3	50	0/16
Copper	16/16	354		
Lead	14/16	56.3		
Manganese	4/4	230		
Mercury	1/16	0.13 P	0.025	1/1
Nickel	8/12	46.7		
Selenium	1/7	51.8	71	0/7
Silver	10/16	2.1		
Thallium	4/12	6.6 J		
Vanadium	3/4	42 P		
Zinc	15/16	240		
Dissolved Metals in µg/L				
Antimony	12/12	17.7		
Arsenic	0/12	N/A		
Beryllium	0/8	N/A		
Cadmium	7/12	4.2 J	8	0/12
Chromium	11/12	4.1		
Copper	12/12	21.3	10.6	8/12
Lead	3/12	1	5.8	0/12
Mercury	2/12	0.59		
Nickel	8/8	47.3	7.9	6/8
Selenium	1/3	51.8 J		
Silver	7/12	0.78 J	1.2	0/12
Thallium	5/8	3.6		
Zinc	9/12	232	77	3/12
Volatiles in µg/L				
Benzene	0/2	N/A		
Vinyl Chloride	0/2	N/A		

Table 7 - Summary of Seep Quality Data for Landfill Area

Sheet 2 of 2

	Detection Frequency	Maximum Detection	Seep Discharge Screening Level (2)	Exceedence Frequency (1)
Semivolatiles in µg/L				
2,4-Dimethylphenol	0/2	N/A		
Benzo(a)Anthracene	0/2	N/A	300	0/2
Benzo(a)Pyrene	0/2	N/A	300	0/2
Benzo(b)Fluoranthene	0/2	N/A	300	0/2
Dibenzo(a,h)Anthracene	0/2	N/A	300	0/2
Di-N-Butylphthalate	0/2	N/A		
Fluoranthene	0/2	N/A	300	0/2
Indeno(1,2,3-c,d)Pyrene	0/2	N/A	300	0/2
Total CPAHs	0/2	N/A		
Pesticide/PCBs in µg/L				
4,4'-DDD	0/7	N/A	0.001	0/0
4,4'-DDE	0/7	N/A	0.001	0/0
4,4'-DDT	0/7	N/A	0.001	0/0
Aldrin	0/7	N/A	0.0019	0/0
PCB-1254	3/17	0.12	0.03	3/3
PCB-1260	1/17	0.11	0.03	1/1
Total PCBs	3/17	0.12	0.03	3/3
Total Petroleum Hydrocarbons in mg/L				
Diesel	0/13	N/A	1	0/13
Gasoline	0/1	N/A	1	0/1
Oil	0/12	N/A	1	0/12

- (1) Undetected sample results with quantitation limits greater than screening levels were excluded from exceedence frequency calculations.
- (2) Seep discharge screening level based on protection of marine aquatic life.

419119/ROD-Revised.xls - Table 7

Table 8 - Summary of Surface Water and Seep Quality Data for Fire Training Area

	Detection Frequency	Maximum Detection	Seep Discharge Screening Level (2)	Exceedence Frequency (1)
Volatiles in µg/L				
Benzene	0/1	ND		
Vinyl Chloride	0/1	ND		
Pesticide/PCBs in µg/L				
PCB-1254	0/2	ND	0.03	0/0
PCB 1260	0/2	ND	0.03	0/0
Total PCBs	0/2	ND	0.03	0/0
Total Petroleum Hydrocarbons in mg/L				
Diesel (3)	1/9	5.2 D	1	1/9
Gasoline	0/3	ND	1	0/3
Oil	0/7	ND	1	0/7

- (1) Undetected sample results with quantitation limits greater than screening levels were excluded from exceedence frequency calculations.
- (2) Seep discharge screening level based on protection of marine aquatic life.
- (3) The only exceedence was a detection of diesel associated with discharge from a drain pipe to a pond in the southern portion of the Fire Training Area.

419119/ROD-Revised.xls - Table 8

Table 9 - Summary of Surface Water and Seep Quality Data for Net Depot Area

Sheet 1 of 2

	Detection Frequency	Maximum Detection	Seep Discharge Screening Level (2)	Exceedence Frequency (1)
Inorganics in µg/L				
Cyanide	2/4	10.8	1	2/2
Total Metals in µg/L				
Antimony	4/4	5.2 J		
Arsenic	0/4	ND	36	0/4
Beryllium	0/4	ND		
Cadmium	1/4	3.3 J		
Chromium	4/4	8.4	50	0/4
Copper	4/4	8.4 J		
Lead	2/4	1.1		
Mercury	0/4	ND	0.025	0/0
Nickel	4/4	10.9 J		
Selenium	0/4	ND	71	0/4
Silver	2/4	1.3 J		
Thallium	2/4	10.9 J		
Zinc	3/4	70.4		
Dissolved Metals in µg/L				
Antimony	4/4	3.6 J		
Arsenic	0/4	ND		
Beryllium	0/4	ND		
Cadmium	1/4	3.4 J	8	0/4
Chromium	3/4	3.3 J		
Copper	4/4	30.6	10.6	1/4
Lead	0/4	ND	5.8	0/4
Mercury	0/4	ND		
Nickel	4/4	11.2 J	7.9	1/4
Selenium	0/4	ND		
Silver	2/4	0.67	1.2	0/4
Thallium	3/4	7 J		
Zinc	3/4	53.6	77	0/4
Volatiles in µg/L				
Benzene	0/4	ND		
Vinyl Chloride	0/4	ND		
Semivolatiles in µg/L -				
2,4-Dimethylphenol	0/4	ND		
Benzo(a)Anthracene	0/4	ND	300	0/4
Benzo(a)Pyrene	0/4	ND	300	0/4
Benzo(b)Fluoranthene	0/4	ND	300	0/4
Dibenzo(a,h)Anthracene	0/4	ND	300	0/4
Di-N-Butylphthalate	0/4	ND		

Table 9 - Summary of Surface Water and Seep Quality Data for Net Depot Area

Sheet 2 of 2

	Detection Frequency	Maximum Detection	Seep Discharge Screening Level (2)	Exceedence Frequency (1)
Fluoranthene	0/4	ND	300	0/4
Indeno(1,2,3-c,d)Pyrene	0/4	ND	300	0/4
Total cPAHs	0/4	ND		
Pesticide/PCBs in µg/L				
4,4'-DDD	0/4	ND	0.001	0/0
4,4'-DDE	1/4	0.0021	0.001	1/1
4,4'-DDT	1/4	0.0032	0.001	1/1
Aldrin	0/4	ND	0.0019	0/0
PCB-1254	0/4	ND	0.03	0/0
PCB-1260	0/4	ND	0.03	0/0
Total PCBs	0/4	ND	0.03	0/0
Total Petroleum Hydrocarbons in mg/L				
Diesel	0/4	ND	1	0/4
Oil	0/4	ND	1	0/4

(1) Undetected sample results with quantitation limits greater than screening levels were excluded from exceedence frequency calculations.

(2) Seep discharge screening level based on protection of marine aquatic life.

419119/ROD-Revised.xls - Table 9

Table 10 - Summary of Sediment Quality Data for Clam Bay

Sheet 1 of 2

	Detection Frequency	Maximum Detection	Screening Level	Exceedence Frequency (1)
Total Metals in mg/kg				
Antimony	23/68	41.5		
Arsenic	77/78	56.5	5/	0/78
Beryllium	22/23	0.4 P		
Cadmium	52/78	8.35	5.1	2/78
Chromium	76/78	184.2 J	260	0/78
Copper	76/78	19400	390	6/78
Lead	70/78	1510	450	4/78
Manganese	16/16	703		
Mercury	59/77	0.489	0.41	3/77
Nickel	23/23	494		
Selenium	0/23	N/A		
Silver	23/78	5.5 N	6.1	0/78
Thallium	6/23	0.33 J		
Vanadium	16/16	111		
Zinc	78/78	3100	410	15/78
Semivolatiles in mg/kg OC				
Benzo(a)Anthracene	14/27	37.975	110	0/27
Benzo(a)Pyrene	12/27	27.848	99	0/27
Di-N-Butylphthalate	2/17	19 J	220	0/17
Dibenzo(a,h)Anthracene	1/27	7.468	12	0/27
Fluoranthene	21/27	167.5	160	1/27
Indeno(1,2,3-c,d)Pyrene	10/27	24.051	34	0/27
Total Benzo(a)fluoranthenes	15/27	70.89	230	0/27
Semivolatiles in µg/kg				
2,4-Dimethylphenol	1/17	92	29	1/17
Pesticide/PCBs in µg/kg				
4,4'-DDD	4/17	6.4 J		
4,4'-DDE	6/17	2		
4,4'-DDT	5/17	170		
Aldrin	1/17	0.4		
Total PCBs	68/93	6470	130	23/92
Dioxins in ng/kg				
2378-TCDD	4/7	2.7 J		
12378-PeCDD	3/5	7.5 J		
123478-HxCDD	2/5	5.3 J		
123678-HxCDD	3/5	18 J		
123789-HxCDD	4/5	18.8 J		
1234678-HpCDD	8/8	103		
OCDD	9/9	1760		

Table 10 - Summary of Sediment Quality Data for Clam Bay

Sheet 2 of 2

	Detection Frequency	Maximum Detection	Screening Level	Exceedence Frequency (1)
2378-TCDF	4/5	23.3		
12378-PeCDF	4/5	18.8	J	
23478-PeCDF	4/5	33.5		
123478-HxCDF	4/5	83.8		
123678-HxCDF	4/5	27.1	J	
123789-HxCDF	3/5	1.4	J	
234678-HxCDF	5/5	37.2	J	
1234678-HpCDF	5/5	109		
1234789-HpCDF	3/5	7.5	J	
OCDF	5/5	94.3		
2378-TCDD Equivalents	9/9	51		

(1) Undetected sample results with quantitation limits greater than screening levels were excluded from exceedence frequency calculations.

419119/ROD-Revised.xls - Table 10

Table 11 - Summary of Tissue Quality Data for Clam Bay

	Detection Frequency	Maximum Detection	Screening Level	Exceedence Frequency (1)
Total Metals in mg/kg				
Antimony	0/7	ND	0.54	
Arsenic	14/14	16	4.5	1/14
Beryllium	0/7	ND	0.0007	0/0
Cadmium	13/14	0.5	0.68	0/14
Chromium	10/14	1.6	6.8	0/14
Copper	14/14	76.16 J	50	1/14
Lead	10/14	3.4882 J		
Manganese	14/14	211	6.8	2/14
Mercury	9/14	0.0544 J	0.41	0/14
Nickel	13/14	2	27	0/14
Selenium	10/14	6	6.8	0/14
Silver	13/14	1.2 J	6.8	0/14
Thallium	0/7	ND	0.11	0/1
Zinc	14/14	53.9	410	0/14
Semivolatiles in µg/kg				
2,4-Dimethylphenol	0/7	ND	27	0/0
Benzo(a)Anthracene	9/16	21.42	4.3	1/9
Benzo(a)Pyrene	9/16	6.174	0.59	6/9
Benzo(b)Fluoranthene	9/16	10.458	4.3	1/9
Dibenzo(a,h)Anthracene	7/16	0.504	0.43	1/9
Di-N-Butylphthalate	0/7	ND		
Fluoranthene	11/16	75.6	54000	0/16
Indeno(1,2,3-c,d)Pyrene	9/16	3.024	4.3	0/9
Pesticide/PCBs in µg/kg				
4,4'-DDD	4/16	3.422	13	0/15
4,4'-DDE	9/16	7.198	9.3	0/16
4,4'-DDT	5/16	36	9.3	1/16
Aldrin	0/16	ND	0.24	0/6
Total PCBs	13/16	656.727	14	13/13
Dioxins in ng/kg				
2378-TCDD	2/5	0.48	0.09	2/4
12378-PeCDD	0/4	ND	0.04	0/0
123478-HxCDD	0/4	ND	0.2	0/4
123678-HxCDD	1/4	0.81	0.69	1/4
123789-HxCDD	0/4	ND	0.2	0/4
1234678-HpCDD	5/6	4.9	2.5	2/6
OCDD	6/6	31.5	20	2/6
2378-TCDF	4/4	0.86	0.79	1/4
12378-PeCDF	0/4	ND	0.4	0/4
23478-PeCDF	1/4	0.62	0.4	1/4
123478-HxCDF	1/4	0.57	0.2	1/4
123678-HxCDF	0/4	ND	0.2	0/2
123789-HxCDF	0/4	ND	0.2	0/4
234678-HxCDF	1/4	0.17	0.23	0/4
1234678-HpCDF	2/4	1.2	2	0/4
1234789-HpCDF	0/4	ND	2	0/4
OCDF	1/4	1.9	20	0/4
2378-TCDD Equivalents	6/6	0.69		

(1) Undetected sample results with quantitation limits greater than screening levels were excluded from exceedence frequency calculations.

Table 12 - Maximum Concentrations Detected in Site Media

Chemical of Concern	Maximum Detected Soil Concentration in mg/kg	Maximum Detected Sediment Concentration in mg/kg	Maximum Detected Groundwater Concentration (a) in ug/L	Maximum Detected Seep Concentration in ug/L	Maximum Detected Shellfish Tissue Concentration in ug/kg (wet weight)
INORGANICS:					
Arsenic	52.3	56.5	109	ND	16000
Asbestos	(b)	NA	NA	NA	NA
Cadmium	22800	8.35	13.1 (c)	4.2 J(c)	500
Copper	23400	19400	179 (c)	30.6 (c)	76200 J
Lead	56000	1510	7.2 (c)	1 (c)	3490 J
Nickel	926	494	252 (c)	47.3 (c)	2000
Silver	67600	5.5	1.6 (c)	0.78 J(c)	1200 J
Zinc	23800	3100	5740 (c)	232 (c)	53900
ORGANICS:					
Vinyl Chloride	0.28	NA	ND	ND	NA
2,4-Dimethylphenol	ND	0.092	ND	ND	ND
Total PCBs	8.9	6.47	ND	0.12	660
2,3,7,8-TCDD Equiv.	0.026	0.000051	0.00036 (d)	NA	0.00069
TPH (as diesel)	15000	NA	1100	ND	NA

J Estimated concentration.

NA Not analyzed.

ND Not detected.

Notes:

- (a) Groundwater samples collected from the landfill area unless otherwise noted.
- (b) Two samples collected from test pits in the landfill area contained 75 to 80 percent fibrous asbestos. Asbestos was not observed in any other site areas.
- (c) Dissolved concentration.
- (d) Groundwater sample collected from the Outwash Channel Aquifer.

Table 13 - TPH Soil-to-Leachate Ratios in Fire Training Area

Sample ID	Sample Depth in Feet	TPH Soil Conc. in mg/kg	TPH SPLP Conc. in mg/L	Soil/Leachate Ratio Unitless
94MAN001B10	0 to 2.5	7,970	1.25 UJ	>6,376
94MAN002B11	2.5 to 5	13,990	2 J	6,995
94MAN002B13	2.5 to 5	10,700	2	5,350
94MAN002B14	2.5 to 5	15,840	2.5 UJ	>6,336
94MAN003B12	5 to 7.5	1,140	1.13 J	1,009
94MAN003B13	5 to 7.5	11,650	2.7	4,315

Notes:

* TPH is sum of diesel and oil fractions

> Soil-to-Leachate ratio is minimum value, based on nondetected leachate concentration

UJ = Not detected at estimated detection limit indicated

J = Estimated value

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Table 14 - Summary of Cumulative Baseline Cancer Risks and Hazard Indices, Manchester Annex Site

Exposure Scenario	Cancer Risk		Hazard Index	
	Average Exposure	Reasonable Maximum Exposure	Average Exposure	Reasonable Maximum Exposure
On-Site Worker	4.E-06	9.E-04	0.4	260
Occasional Site Visitor (Child)	-	1.E-03	-	1,000
Subsistence Fisher	2.E-05	6.E-05	0.7	3

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Table 15 - Summary of Manchester Annex Cleanup Levels and Cleanup Goals

Chemical of Concern	Cleanup Level	Basis	Cleanup Goal	Basis	Point of Compliance
Landfill Area - Seeps					
Copper	10.6 ug/L	Regional background			Seep Discharge
Nickel	7.9 ug/L	WAC 173-201A marine chronic			Seep Discharge
Zinc	77 ug/L	WAC 173-201A marine chronic			Seep Discharge
Total PCBs	0.03 ug/L	WAC 173-201A marine chronic			Seep Discharge
Clam Bay - Sediments					
Copper	390 mg/kg dry	WAC 173-204 SQS			0 to 10 cm depth
Lead	450 mg/kg dry	WAC 173-204 SQS			0 to 10 cm depth
Silver	6.1 mg/kg dry	WAC 173-204 SQS			0 to 10 cm depth
Zinc	410 mg/kg dry	WAC 173-204 SQS			0 to 10 cm depth
2,4-Dimethylphenol	29 ug/kg dry	WAC 173-204 SQS			0 to 10 cm depth
Total PCBs	130 ug/kg dry	Lowest AET (Ecology, 1988)	40 ug/kg dry	Bioaccumulation correlation (est.)	0 to 10 cm depth
Clam Bay - Tissue					
Total PCBs	N/A (b)		42 ug/kg wet (c)	Subsistence fishing	Intertidal clams
Fire Training Area - Soil					
2,3,7,8-TCDD Equiv. TPH (as diesel)	270 ng/kg N/A (d)	WAC 173-340 Method C	200 mg/kg	WAC 173-340 Method A	0 to 15 ft depth

NOTES:

- Insufficient toxicity data are available to derive a reliable sediment cleanup level for nickel (reduction of nickel concentrations will result from attainment of other chemical cleanup levels).
- Existing (baseline) site concentrations are at or below risk-based cleanup levels except for the subsistence fishing scenario.
- A tissue PCB cleanup goal of 42 ug/kg wet weight is associated with a cumulative cancer risk of 1×10^{-5} for a subsistence fishing scenario. Risks associated with subsistence fishing can be controlled by implementing temporary limitations on subsistence-level consumption during the initial recovery period.
- Sites-specific risk assessment and leachability testing indicated only a low risk associated with TPH; consequently, no chemical-specific cleanup level is necessary.

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Table 16 - Estimated Areas and Volumes Exceeding Soil and Sediment Cleanup Levels

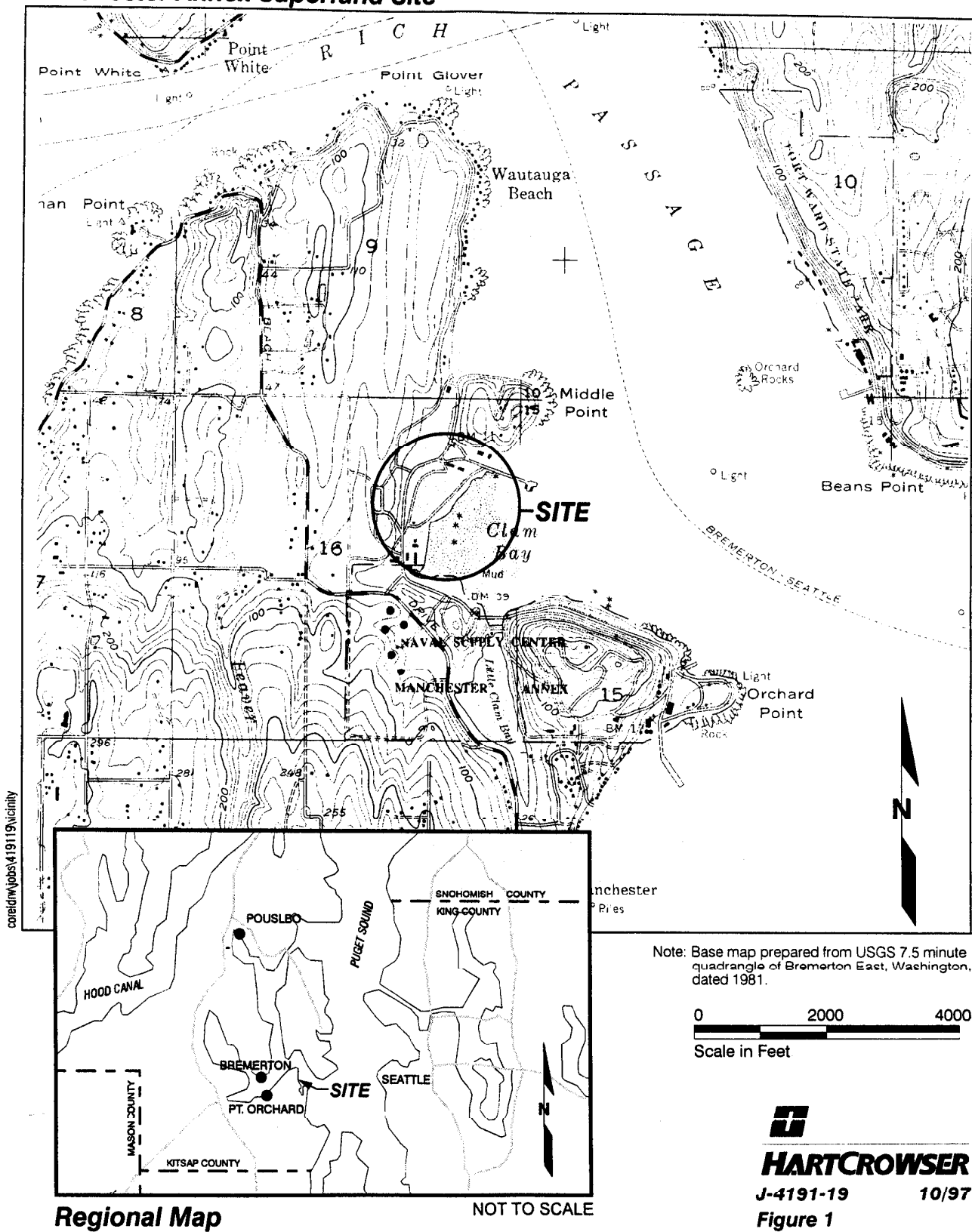
Description	Area in sq ft ⁽⁴⁾	Average Depth in Feet	Volume in CY ⁽⁴⁾
Landfill and Clam Bay (1)			
Landfill debris and cap material	270,000	7	70,000
Silt basin offshore of north end of landfill	2,700	8	800
Intertidal surficial sediments	210,000	0.5	3,900
Fire Training Area (2)			
Debris inside simulators	2,600	2	190
Dioxin-impacted surficial soil around simulators	3,200	1	120
Debris/soil pile north of main simulator complex	830	4	120
Soil at main simulator complex exceeding cleanup goal for TPH (3)	30,000	8	8,800
Soil at former fire training stations and UST exceeding cleanup goal for TPH (3)	3,400	4	500
Net Depot and Manchester State Park			
Complies with soil and sediment cleanup levels			

- (1) Soil and sediment areas exceeding cleanup levels in the landfill area and Clam Bay are shown on Figure 7.
- (2) Soil areas exceeding cleanup levels and cleanup goals in the Fire Training Area are shown on Figure 8.
- (3) No cleanup level has been established for TPH.
- (4) Area and volume estimates are provided to two significant figures.

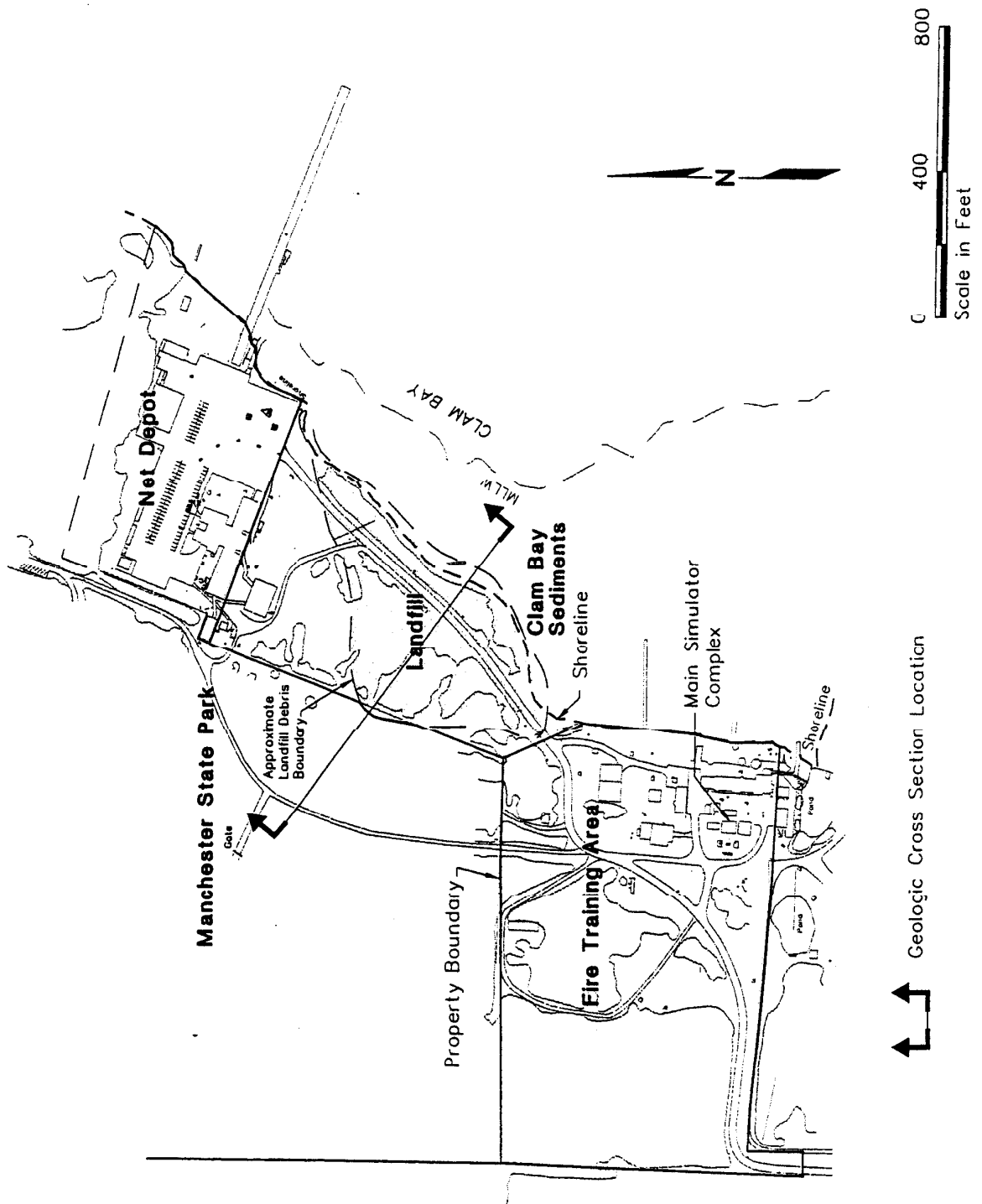
419119/ROD-Revised.xls - Table 16

Vicinity Map

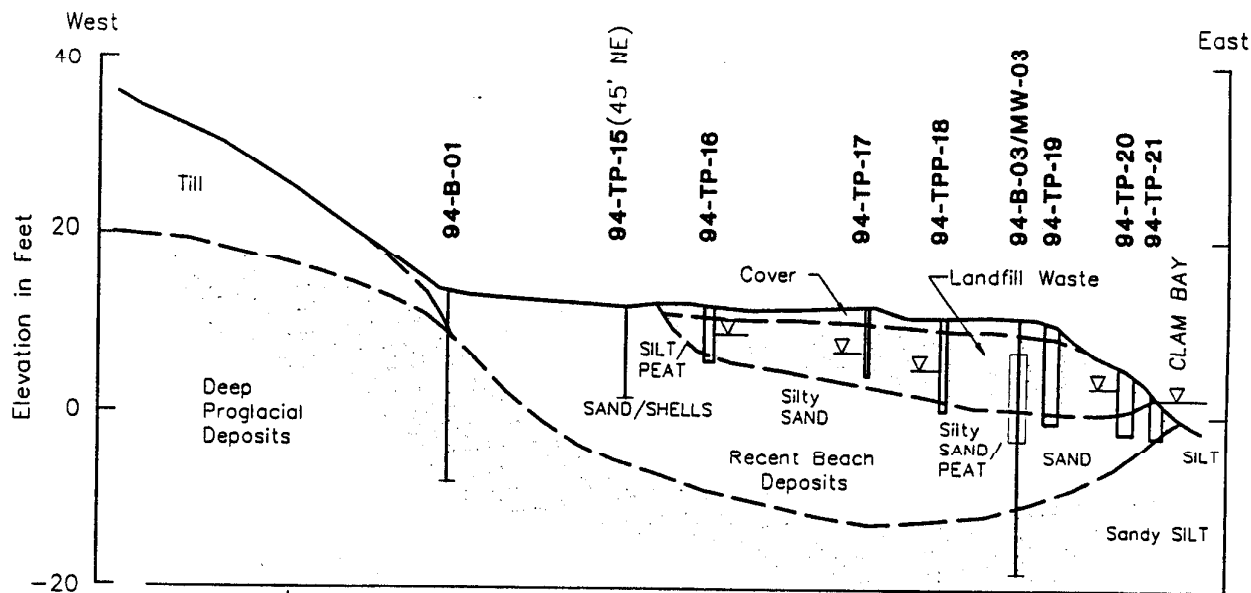
Manchester Annex Superfund Site



Site Features Map



Geologic Cross Section



94-TP-15 (45' NE)

Offset Distance and Direction

Exploration Number

Boring/Monitoring Well Location

Water Level At Time of Drilling

Screened Section

Test Pit Location

Horizontal Scale in Feet
0 200 400

Vertical Scale in Feet
0 20 40
Vertical Exaggeration x10

Soil Containing
Fine-Grained
(Silt or Clay) Matrix



HARTCROWSER

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Figure 3